Optisure Optical Hygrometer User's Manual

Optisure Rack-Mount Version

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Safety

The manufacturer has designed this equipment to be safe when operated using the procedures detailed in this manual. The user must not use this equipment for any other purpose than that stated. Do not apply values greater than the maximum value stated.

This manual contains operating and safety instructions, which must be followed to insure the safe operation and to maintain the equipment in a safe condition. The safety instructions are either warnings or cautions issued to protect the user and the equipment from injury or damage. Use qualified personnel and good engineering practice for all procedures in this manual.

Electrical Safety

The instrument is designed to be completely safe when used with options and accessories supplied by the manufacturer for use with the instrument. The input power supply voltage limits are 85 to 264 V AC, 47/63 Hz. Refer to Appendix A - Technical Specifications.

Pressure Safety

Before pressurizing, the user must insure through appropriate protective measures that the system or the device will not be over-pressurized. When working with the instrument and pressurized gases safety glasses should be worn.

DO NOT permit pressures greater than the safe working pressure to be applied to the instrument. The specified maximum safe working pressure is 14.5 psig (1 barg) for the low pressure version, or 250 psig (17 barg) for the high pressure version. The safety strap MUST be used when operating at pressures above 14.5 psig (1 barg), refer to Section 2.5.10. This instrument is not designed to accept gas pressures higher than the specified maximum working pressure.

Application of gas pressures higher than the specified maximum will result in potential damage and may render the instrument unsafe and in a condition of incorrect functionality. Only personnel trained in the safe handling of high pressure gases should be allowed to operate this instrument. Refer to Appendix A - Technical Specifications in this manual.

Abbreviations

The following abbreviations are used in this manual:

DCC	Dynamic Contamination Correction
FAST	Frost Assurance System Technology
MAXCOOL	Maximum Sensor Cooling
AC	alternating current
atm	pressure unit (atmosphere)
barg	pressure unit (=100 kP or 0.987 atm) gauge
bara	pressure unit (absolute)
°C	degrees Celsius
°F	degrees Fahrenheit
COM	common
dp	dew point
EU	European Union
g/Kg	grams per kilogram
g/m^3	grams per cubic meter
HMI	Human Machine Interface
Hz	Hertz
IEC	International Electrotechnical Commission
Nl/min	normal liters per minute
lb	pound
mA	milliampere
max	maximum
min	minute(s)
mV	millivolt(s)
N/C	normally closed
N/O	normally open
No	number
ppmV	parts per million (by volume)
ppmW	parts per million (by weight)
PRT	Platinum resistance thermometer (typically type Pt100)
psig	pound(s) per square inch (gauge)
psia	pound(s) per square inch (absolute)
RH	relative humidity
RTU	Remote Terminal Unit
scfh	standard cubic feet per hour
SD	storage device card (memory card for storing datalog files)
temp	temperature
USB	Universal Serial Bus
V	Volts

Warnings

The following general warnings listed below are applicable to this instrument. They are repeated in the text in the appropriate locations.

Where this hazard warning symbol appears in the following sections, it is used to indicate areas where potentially hazardous operations need to be carried out.

Where this symbol appears in the following sections it is used to indicate areas of potential risk of electric shock.

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1 INTRODUCTION

The Optisure Optical Hygrometer is a high precision instrument used for the measurement of moisture content in air and other gases. Relative humidity and other calculated parameters based on dew point, pressure and temperature of the sample gas can also be displayed.

The Optisure Optical Hygrometer is capable of measuring dew points as low as -60°C (-76°F); it can measure dew points up to (but not including) the point of condensation (maximum +40°C (+104°F)).

Four models of the Optisure Optical Hygrometer instrument are available:

- Vertical model
  - Low Pressure (14.5 psig (1 barg) max)
  - High Pressure (250 psig (17 barg) max)
- Horizontal model
  - Low Pressure (14.5 psig (1 barg) max)
  - High Pressure (250 psig (17 barg) max)

A rack mounted configuration is available which is a derivative of the horizontal model. Any horizontal model may be converted to a rack mounted version by means of a special rack mounting kit, (refer to Section 2.5.8).

Figure 1 *Optisure - Horizontal Model*

1.1 Operating Principle

The system operates on the chilled mirror principle, whereby a gas sample is passed into the sensor housing and flows over the surface of the chilled mirror contained within. At a temperature dependent upon the moisture content in the gas, and the operating pressure, the moisture in the gas condenses out on the surface of the mirror.

An optical system is used to detect the point at which this occurs, and this information is used to control the mirror temperature and maintain a constant thickness of the condensation layer on the mirror surface.

A light emitting diode (1) (see *Figure 2)* provides a light beam of constant intensity which is focused by a lens system (2) to become the incident beam on the mirror surface (3), flooding it with a pool of light.

Before the light beam reaches the mirror (3), a beam splitter (4) directs part of the beam via a lens system (5) onto a sensor (6) which monitors the intensity of the LED light and provides a feedback loop to keep this at a constant level.

Two sensors (7 and 8) monitor the light level reflected by the mirror. One of these sensors (7) measures the light level due to the reflected incident beam and the other (8) measures the degree of light scatter due to the formation of water/ice on the mirror surface. Each sensor has its own optical lens system (9) and (10) to concentrate the reflected light onto the sensor.

The output from each of these sensors is compared and then used to control the drive to a Peltier heat pump (11). Dependant on the result of this comparison, the control system will cause the heat pump (11) to either heat or cool the mirror (3) in order to maintain the desired condensation film thickness on the mirror surface.

At an equilibrium point, where the evaporation rate and condensation rate at the surface of the mirror are equal, the mirror temperature, read by a Pt100 platinum resistance thermometer (12) embedded in the mirror, represents the dew point.

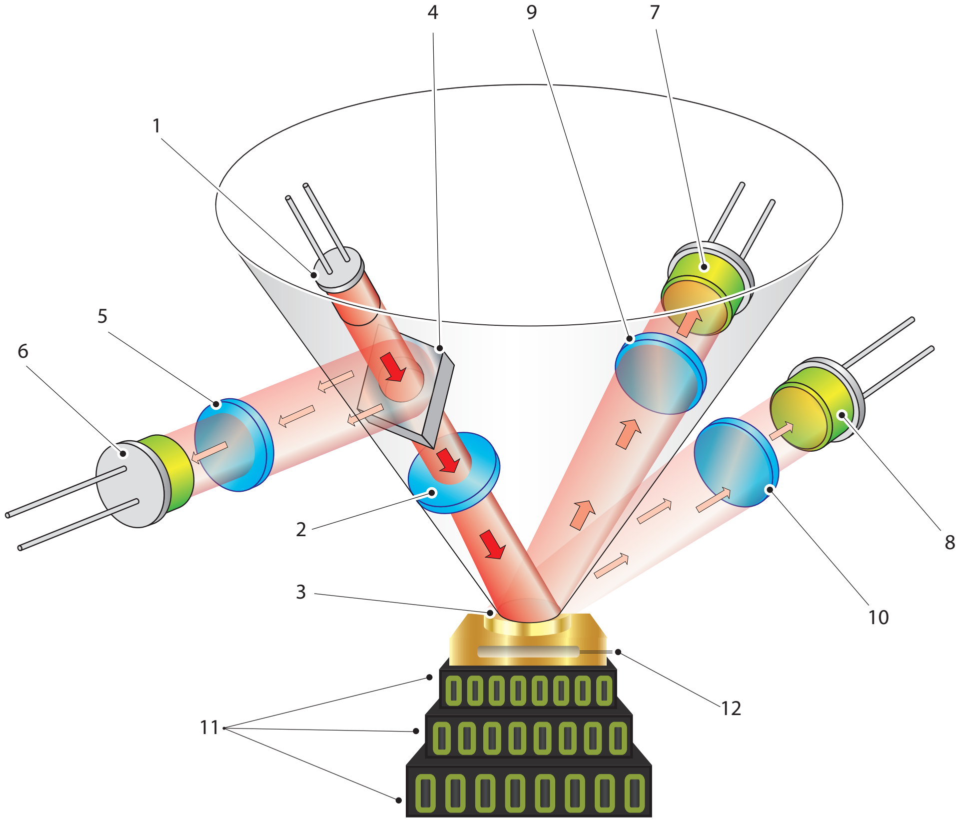


Figure 2 *Operating Principle*

2 INSTALLATION

2.1 Safety

It is essential that the installation of the electrical and gas supplies to this instrument be undertaken by competent personnel.

2.2 Unpacking the Instrument

Both the horizontal and vertical models are packed in a similar manner. *Figure 3* shows the unpacking method.

NOTE: The free-standing, horizontal version may be converted to a rack mounted instrument by means of an optional rack mounting kit (refer to Section 2.5.8).

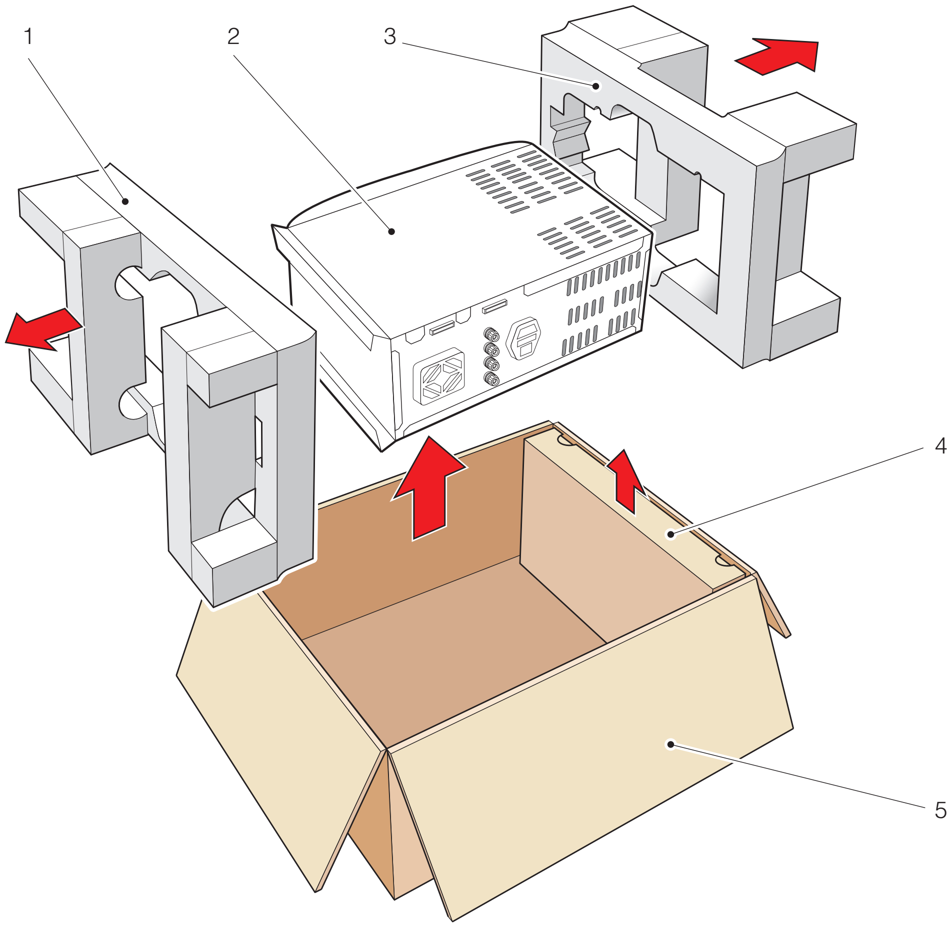


Figure 3 *Optisure Optical Hygrometer Packing*

Open the box and unpack carefully as follows (see *Figure 3)* :

1. Remove the accessories box (4).
2. Lift out the instrument (2) together with its end packing pieces (1) and (3).
3. Remove the end packing pieces (1) and (3) set the instrument down at the site of installation.
4. Save all the packing materials for the purpose of returning the instrument for re-calibration or any warranty claims.

The accessories box should contain the following items (refer to *Figure 4):*

1. Traceable calibration certificate
2. SD memory storage card
3. Optics cleaning kit
4. Microscope (optional)
5. USB communications cable
6. Pt100 temperature probe (optional)
7. IEC power cable
8. Application software CD
9. User's manual
10. Safety strap (supplied with High Pressure versions)

If there are any shortages, please notify Kahn Instruments immediately (see www.kahn.com for contact information).

Figure 4 *Optisure Accessories*

2.3 Operating Requirements

2.3.1 Environmental Requirements

The horizontal and vertical Optisure instruments should be placed on a firm and level surface in a standard laboratory environment. Recommended ambient temperature +68 to +77°F (+20 to +25°C) although the instrument will operate, within specification, at elevated ambient temperatures of up to +122°F (+50°C), providing the cooling vents are kept clear and unrestricted. **It is essential however that this upper temperature limit (+122°F / +50°C) is not exceeded.**

A free flow of air around the instrument is required at all times.

Rack mounted versions are suitable for mounting in standard 19" racks. The siting of these racks should be in a dry, dust free environment at a recommended ambient temperature of +68 to +77°F (+20 to +25°C).

For rack mounted instruments, forced air cooling of the rack should be considered if operating at high ambient temperatures.

2.3.2 Electrical Requirements

All versions of the instrument require the following electrical supply:

- 85 to 264 V AC, 47/63 Hz, 100 VA max
- Alarm outputs for all instrument types comprise two sets of changeover relay contacts, one set for a **PROCESS** alarm and one set for an **INSTRUMENT FAULT**. Both sets of contacts are rated at 24 V, 1A. **NOTE: THIS RATING MUST NOT BE EXCEEDED.**

2.4 Exterior Layout

The controls and indicators relating to the operator interface are located on the front panel, along with the gas inlet and outlet.

The external PRT connection, power IEC socket, analog output connector, remote temperature probe connector, alarm relay connector, and the USB socket are located on the rear panel.

Figures 5 and 6 show the layout of these controls for both the rack mount/horizontal and vertical versions of the instrument. Tables 1 and 2 detail the controls and indicators and the function key operations.

The microscope should not be used when the system is operating at pressures above 14.5 psig (1 barg).

The safety strap should be installed when the the system is operating at pressures above 14.5 psig (1 barg) (see Section 2.5.10).

Front Panel

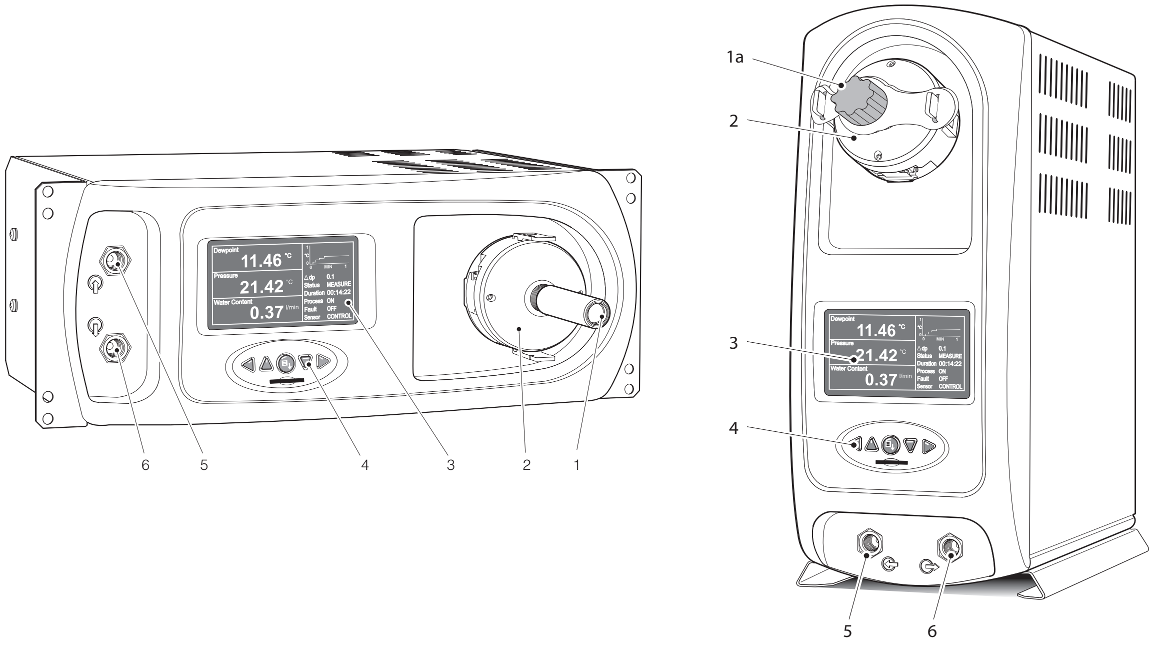


Figure 5 *Front Panel*

Item	Description
1	**Microscope** - For viewing mirror surface. The microscope is removable and must not be used at pressures above 14.5 psig (1 barg).
1a	**Safety Strap -** Must be equipped when the system is operating at pressures above 14.5 psig (1 barg). Refer to Section 2.5.10.
2	**Exterior housing of the sensor -** See Section 5.4 for instructions on how to open the housing and clean the mirror.
3	**Instrument display** - Partitioned to show three main panes each of which can be configured to display one of the ten available output parameters. A second area of the display shows a stability graph, and other process related data. Refer to Section 3.3.
4	**Function keys** - Used to control the instrument functions and navigate through the menu system. Refer to Section 2.2.
5	**Gas input port** - Usually slightly above atmospheric pressure in order to maintain flow rate over the mirror, but can be at elevated pressure depending upon application.
6	**Gas output port** - Usually vented to atmosphere but can be at elevated pressures depending upon application.

Table 1 Front Panel Controls and Indicators

Rear Panel

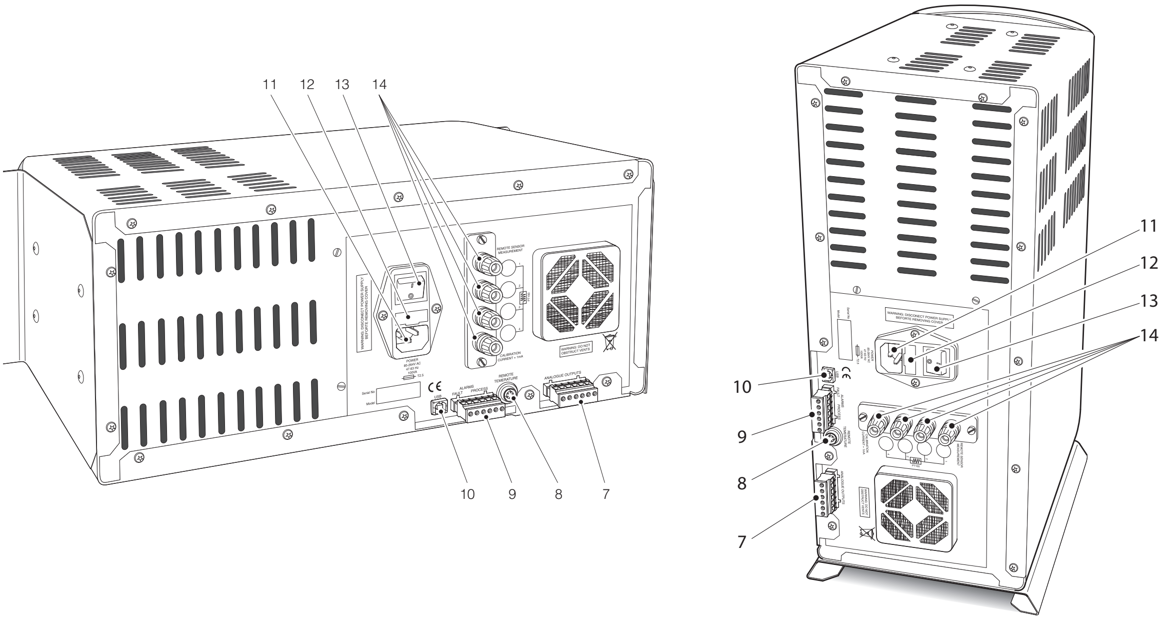


Figure 6 *Rear Panel*

Item	Description
7	**Analog output connector** - Three, 2-wire output channels, CH1, CH2 and CH3, each of which may be configured to give either a 0-20 mA or a 4-20 mA current loop output or a 0 to 1000 mV voltage signal representing any one of the measured or calculated output parameters selected. Spans for each signal output are separately configurable. Refer to Section 2.5.2.
8	**Remote temperature probe (optional)** - 6-Pin Lemo socket for connection of remote Pt100 temperature probe.
9	**Alarms** - Process and Fault alarm outputs. Each alarm has one set of potential free, changeover, relay contacts, common (COM), normally closed (N/C) and normally open (N/O). The Process alarm can be configured to operate at a specified level on any of the measured or calculated parameters. Refer to Section 2.5.3.
10	**USB communications port** - Used for connection to an external computer system for running application software (optional).
11-13	**IEC Power supply input socket and power ON/OFF switch** - Universal power input 85 to 264 V AC, 47/63 Hz / Fuse - 2.5 A, Anti-Surge, Glass, 20mm x 5mm (12) / Features integrated power ON/OFF switch (13).
14	**4-wire PRT bridge output** - Banana sockets for external 4-wire measurement of the internal PRT. Active only when PRT set to External from Display options, and instrument is in the MEASURE phase. In this mode the dew-point display is set to read zero, DCC is set to OFF and manual DCC is also disabled.

Table 2 Rear Panel Controls and Indicators

2.5 Rear Panel Connections (All Versions)

These tasks should be undertaken only by competent personnel.

DANGER
Electric
Shock Risk

All the connections to the rear panel are electrical connections.

Exercise due caution, particularly when connecting to external alarm circuits which could be at high potential.

Connections to the rear panel of the instrument are explained in the following sections.

2.5.1 Power Supply Input

The AC power supply is a push fit into the power input socket as shown in *Figure 7*. The method of connection is as follows:

1. Insure that both ends of the power cable are potential free i.e. not connected to an AC power supply.
2. Check that the **ON/OFF** switch (1) on the power supply connector is switched to **OFF**.
3. Push the IEC connector (2) firmly into the power input socket (3).
4. Connect the free end of the power cable to a suitable AC power supply source (voltage range 85 to 264 V AC, 47/63 Hz) and switch on the AC supply. The instrument may then be switched on, as required, using the **ON/OFF** switch.

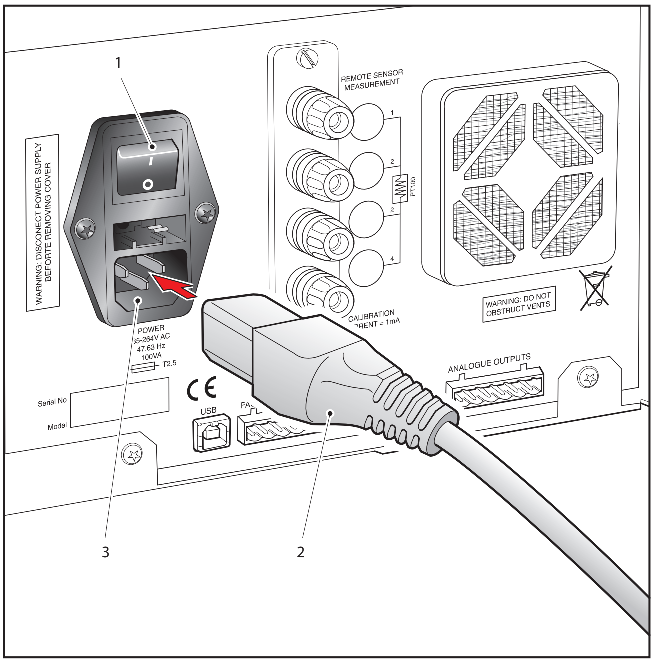


Figure 7 *Power Supply Input*

2.5.2 Analog Output Connections

The three analog outputs can be configured to represent any of the directly measured or calculated output parameters. They are provided as 2-wire signals from a 6-way connector located on the rear panel of the instrument.

Each of these outputs can be set up as either a current loop signal (4-20 mA or 0-20 mA) or alternatively, as a 0-1 V voltage signal. The configuration of these outputs, i.e. parameter represented, output type (current loop or voltage) and upper/lower span levels are set up via the **SETUP** Menu Screen (refer to Section 3.6.4).

These signals may be used to control external systems. During a **DCC** cycle, and for the hold period following a **DCC** cycle, they are held at the level that they were at immediately prior to the start of the cycle. When the dew-point measurement is stable, or if the maximum hold period has expired, they are released and will track the selected parameter throughout the measurement cycle.

The default settings of these analog outputs are:

Channel 1: Dew point, -60 to +40ºC
Channel 2: ppm_V, 0 to 3000
Channel 3: Flow, 0 to 1000 ml/min

NOTE: The analog outputs are only active during the MEASURE **phase. They will, therefore, be off after switch-on and remain off until the system enters the** MEASURE **phase.**

The three analog output ports connections are made via a single, 6-way, push fit connector block as shown in *Figure 8*. All outputs are 2-wire, positive-going signals referenced to a common 0 V line. To differentiate between the outputs it is recommended that a black lead be used for each of the COM (common) lines and a separate color for each of the positive lines.

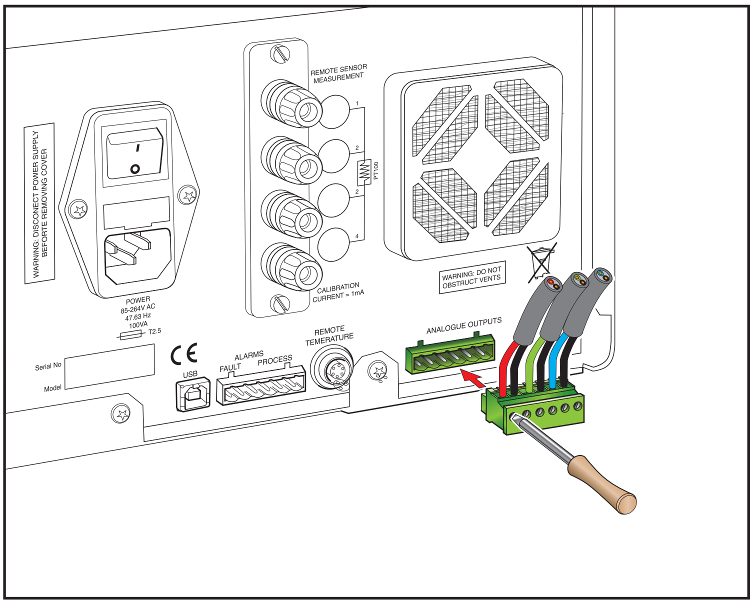


Figure 8 *Analog Output Connectors*

For each output:

1. Remove the terminal block equipped into the analog output socket.
2. Strip back the wire for the common (black) connection to the **CH1** output, exposing approximately 6mm (0.25"). Insert the wire into the **COM1** terminal way and screw into the block. **Do not overtighten the screw.**
3. Strip back the wire for the signal (e.g. red) connection to the **OP1** output, exposing approximately 6mm (0.25"). Insert the wire into the **OP1** terminal way and screw into the block. **Do not overtighten the screw.**
4. Repeat operations 1 and 2 for the other analog outputs, selecting a different color for the **OP2** and **OP3** outputs.
5. Locate the terminal block over the connector labelled **ANALOG OUTPUTS** and push the terminal block firmly into the connector.

2.5.3 Alarm Output Connections

Two alarm outputs are provided from a terminal block (Item 9, *Figure 6),* located on the rear panel of the instrument as two pairs of potential free, change-over relay contacts. These are designated as a **PROCESS** alarm and a **FAULT** alarm.

Under the **SETUP** menu, (refer to Section 3.6.4), the **PROCESS** alarm can be configured to represent any one of the measured or calculated parameters and set-up to operate when a pre-set parameter threshold level is exceeded. By default, the **PROCESS** alarm is set to monitor the dew-point parameter.

The **FAULT** alarm is a non-configurable alarm which continuously monitors the degree of contamination of the chilled mirror. During normal operational conditions, this alarm will be off. If the optics or the mirror contamination exceeds 100% of the film thickness, or if a fault exists on the Pt100, the alarm is triggered, and the relay contacts will change state.

This fault is also reported to the status area of the display.

The two alarm output ports are connected to the instrument via a single 6-way, push-fit connector block as shown in *Figure 9*. Each output comprises a 3-wire set of potential free, change-over relay contacts.

Each contact set is labelled **COM** (common 0 V), **N/O** (normally open with respect to **COM**) and **N/C** (normally closed with respect to **COM**).

To differentiate between the alarm output channels, it is recommended that a black lead be used for each of the **COM** (common) lines and a separate color for each of the **N/O** and **N/C** lines.

DANGER
Electric
Shock Risk

WARNING: Alarm leads MUST be potential free when wiring to connector block.

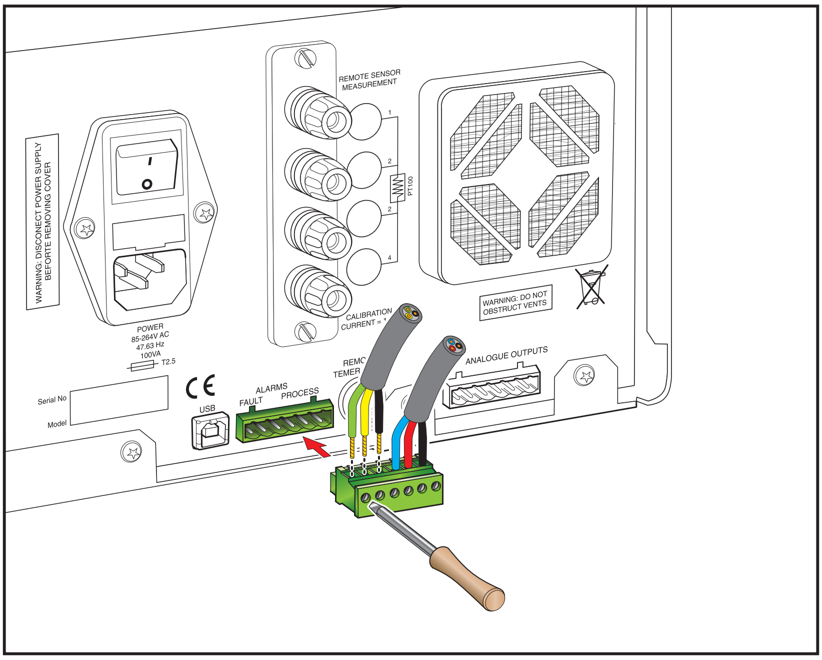


Figure 9 *Alarm Output Connectors*

For each output:

1. Strip back the wire for the common (black) connection to the **COM** connector way for the **FAULT** alarm contact set, exposing approximately 6mm (0.25") wire and clamp into the screw block **COM** terminal way. **Do not overtighten the screw.**
2. Strip back the wire for the **N/O** (e.g. green) connection to the **N/O** connector way for the **FAULT** alarm contact set, exposing approximately 6mm (0.25") wire and clamp into the screw block **N/O** terminal way. **Do not overtighten the screw.**
3. Strip back the wire for the **N/C** (e.g. blue) connection to the **N/C** connector way for the **FAULT** alarm contact set, exposing approximately 6mm (0.25") wire and clamp into the screw block **N/C** terminal way. **Do not overtighten the screw.**
4. Repeat operations 1 to 3 for the **PROCESS** alarm contact set, using appropriate colored wires.
5. Locate the terminal block over the connector labelled **ALARMS** and push the terminal block firmly into the connector.

2.5.4 Remote PRT Probe (Optional)

1. Rotate the body of the PRT probe connector until it locates in the socket labeled **REMOTE TEMPERATURE** (see *Figure 10).*
2. Push the connector into the socket until it locks. **Do not attempt to force it into the socket**. **If it will not fit in, rotate it until the key locks and it pushes in easily.**
3. To remove the connector, slide the connector's body collar (1) back along its axis, away from the instrument to release the lock and then gently pull the connector body out of the socket. **Do not attempt to pull it out with the cable - make sure that the collar is first released.**

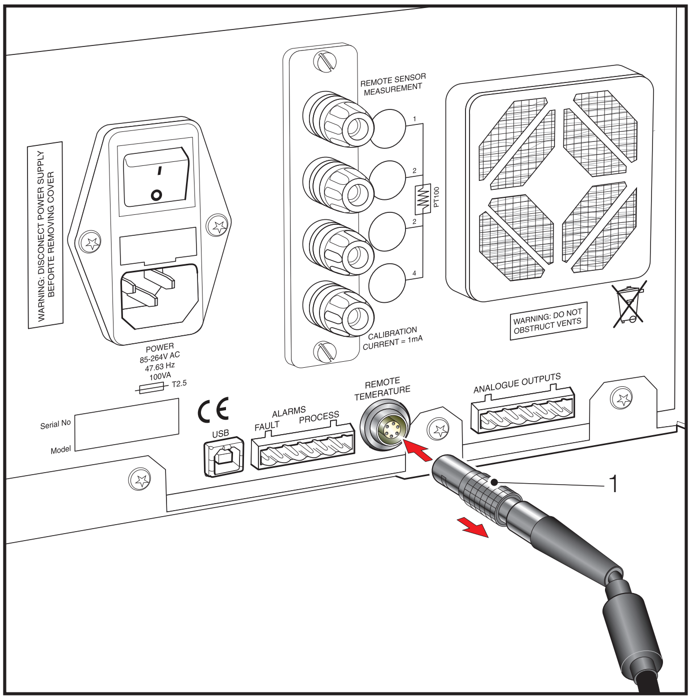


Figure 10 *Remote PRT Connection*

2.5.5 4-Wire PRT Output

These four terminal binding posts (Items 1 to 4, *Figure 11),* are provided for calibration and external monitoring purposes.

Two pairs of lines are provided, two drive and two sense lines. One black (low) and one red (high) for the drive lines, and one black (low) and one red (high) for the sense lines.

Connections to these terminal posts can be made either via 4mm plugs pushed into the ends of the terminal posts or, alternatively, as shown, wires (5) connected round the posts and clamped down by screw action.

To set-up the system for **PRT** output refer to Section 3.10.

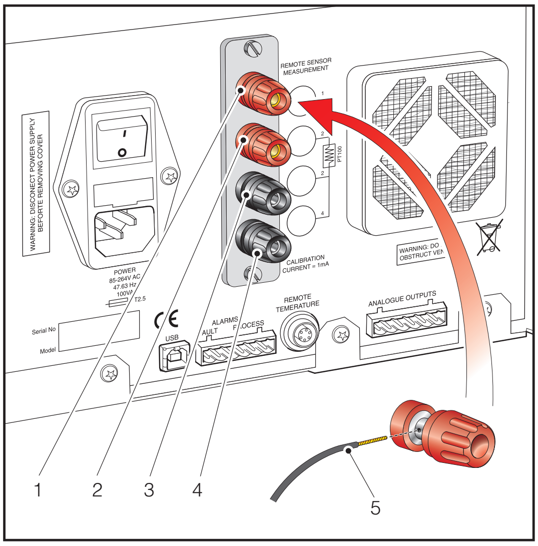


Figure 11 *Internal PRT Output*

2.5.6 USB Communications Port Connector

The instrument features a USB port for communication with the Application Software. The appropriate cable will be supplied with the instrument.

1. Check the orientation of the connector and gently push it into the socket labelled **USB** (see *Figure 12).*
2. To remove the connector, pull it out of the socket by holding the connector body. **Do not attempt to remove it from the socket by pulling on the cable.**

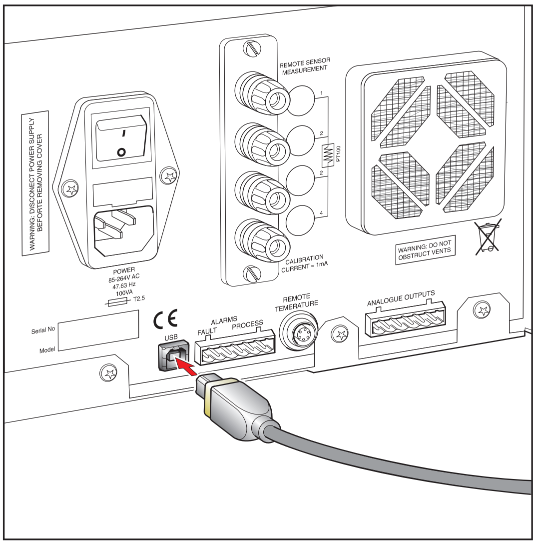


Figure 12 *USB Port Connection*

2.5.7 Connection of Gas Supplies

POSSIBLE INJURY! The tubing, valves and other apparatus attached to this instrument must be adequate for the maximum pressure which will be applied, otherwise physical injury to the operator or bystander is possible.

Before connection or disconnection of the instrument to and from the gas line it is essential to vent the system to atmospheric pressure, otherwise severe injury could result.

The safety strap should be equipped when the the system is operating at pressures above 14.5 psig (1 barg) (see Section 2.5.10).

Sample gas connections are made via the **GAS IN** port (7) and the **GAS OUT** port (8) located on the front panel of all the models. As the method of connection is the same for all types, only the horizontal version has been illustrated (see *Figure 13)*:

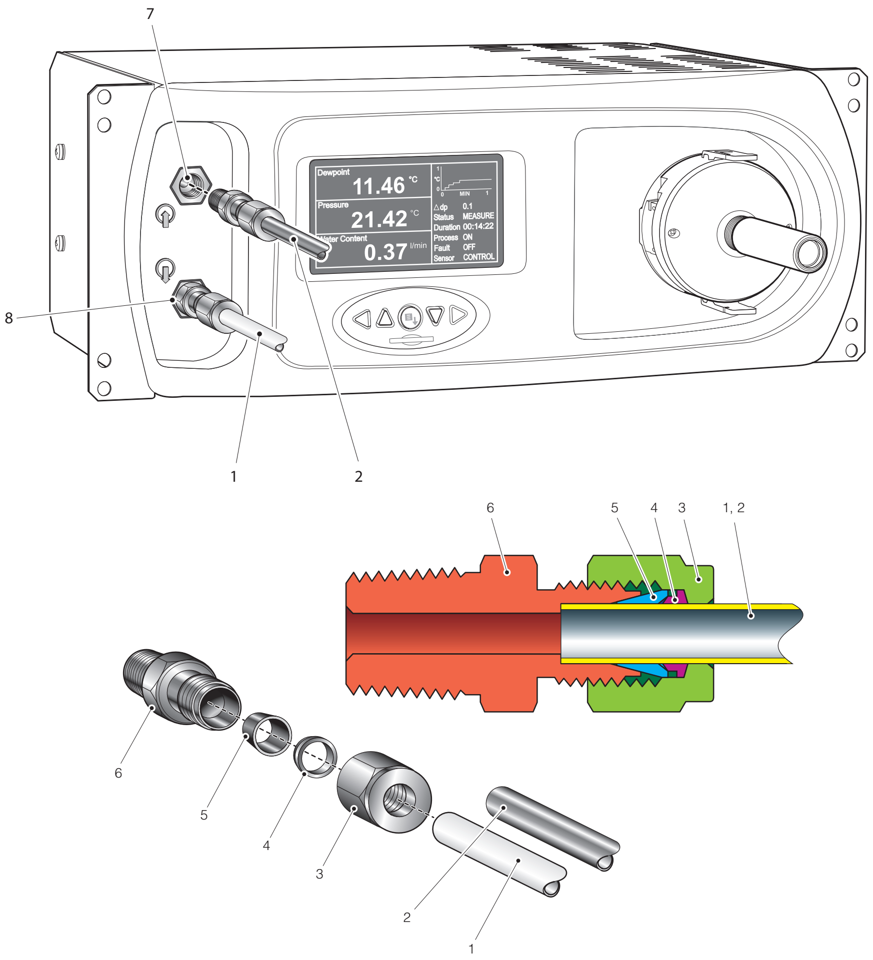


Figure 13 *Gas Connections*

Both the input and output gas connections are ¼" NPT Swagelock® couplings. The gas input connection must always be made via ¼" stainless steel piping. The gas output connection for most applications can just be exhausted to atmosphere via 305mm (12") of PTFE tubing (1).

The method of connection to the **GAS IN** port (7) is as follows.

NOTE: The following description relates to ¼" tube fixings. The instrument ports are both ¼" NPT female fittings. Two sets of tube fittings (adaptor (6), front (5) and back (4) ferrules and locking nut (3) are supplied in the accessories box. EU and CN versions are supplied with 6mm fittings and NA fittings are ¼". Other fittings (3mm and ⅛") are also available to order.

1. Cut ¼" stainless steel tubing (2) to the correct length and, if necessary, bend to shape to suit the location of the instrument. **NOTE: To facilitate ease of connection to the port, at least 3" (75mm) of the tubing coming out of the GAS IN port should be straight**.
2. Clean off any burrs or metal shavings adhering to the tubing.
3. Screw the ¼" NPT Swagelok adaptor (6) into the ¼" NPT inlet port of the instrument and tighten. Wrap the ¼" NPT male thread in one layer of PTFE tape to facilitate a gas tight seal. **CAUTION: Do not overtighten.**
4. Pass the tubing (2) through the locking nut (3). **NOTE: Threads towards the gas port.**
5. Fit the back ferrule (4) over the tubing (2) with the bevelled end facing the back of the front ferrule (5).
6. Place the front ferrule (5) over the tubing (2), bevelled end towards the adaptor (6).
7. Push the tubing as far as it will go into the fitting and tighten up the locking nut (3) finger tight.
8. Hold the adaptor (6) flats with a wrench and tighten up the locking nut (3). This action compresses the front ferrule (5) and back ferrule (4) onto the tubing to form a gas tight seal. **CAUTION: Do not overtighten as this could cause the ferrules to crack and destroy the integrity of the seal.**
9. Connect up the **GAS OUT** port (8) in a similar manner to that described in operations 1 - 8 above using PTFE tubing (1) in place of stainless steel (2).

2.5.8 Conversion of a Horizontal Version to Rack Mount

To convert a Optisure horizontal version to a rack mounted version a rack mounting kit (Optional - Part No. S8K-PKI) is required.

This conversion pack comprises two steel wings (3) and eight cap screws (1), each wing bolting to the side of the instrument with four screws as shown in *Figure 14*.

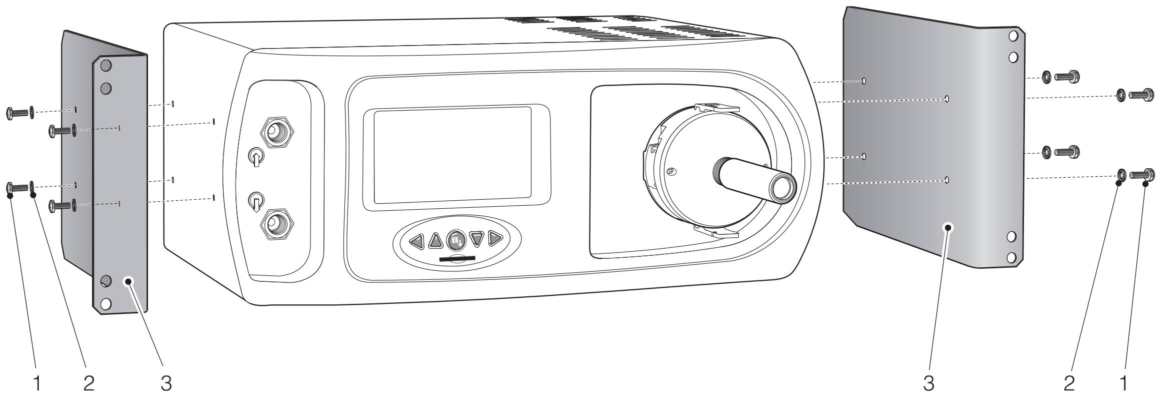


Figure 14 *Conversion of Horizontal to Rack Mount*

1. Turn the unit on its left hand end and line up the fixing holes on the right hand side of the instrument with the corresponding holes in the right hand wing (flange facing outwards).
2. Insert the four cap screws (1) and washers (2) through the wing (3) and tighten finger tight.
3. Insure that the front flange (3) is square to the front of the instrument and tighten the cap screws
4. Turn the unit on its right hand end and repeat operations 1 - 3.

To remove the rack support wings remove the unit from the rack (if necessary) and follow the directions above, in reverse.

2.5.9 Fitting Rack Mounted Version into Rack

Figure 15 illustrates the method for fitting a rack mount instrument into a standard 19" rack. To fit the unit proceed as follows:

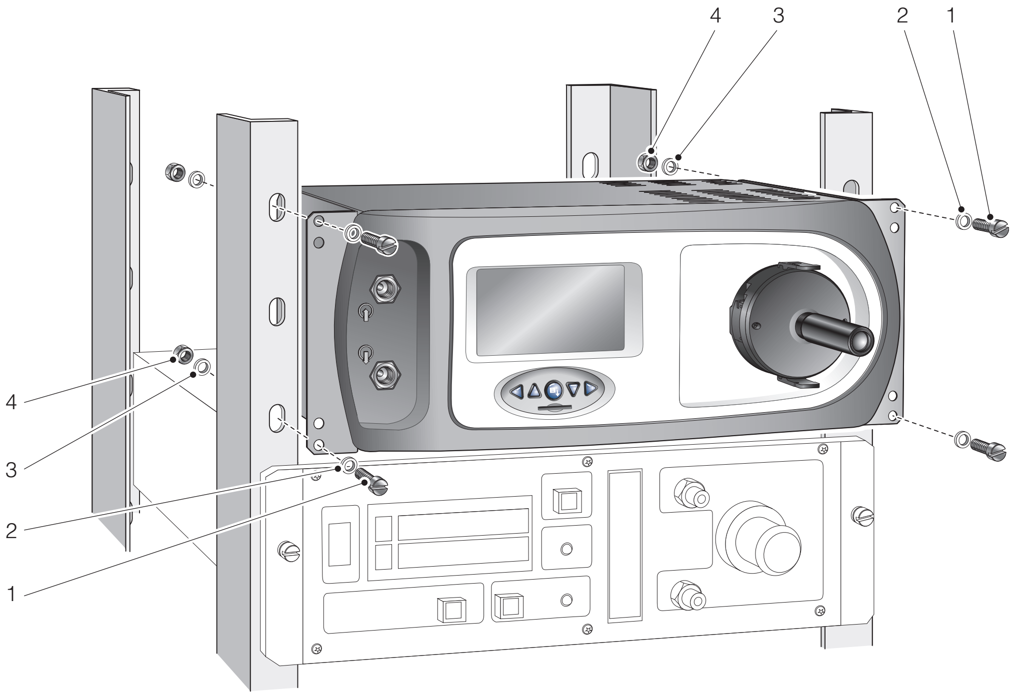


Figure 15 *Rack Mounting Method*

1. Remove the connector blocks from the alarm and analog output sockets.
2. If necessary, remove any covers from the rack cabinet to gain access to the rear and side.
3. Connect up the analog and alarm output connector blocks to the internal rack wiring (refer to Section 2.5), ensuring that there is sufficient free cable to permit withdrawal of the instrument from the rack.
4. Slide the instrument into the rack and support its weight while the four fixing screws are inserted.
5. Insure that the front panel of the instrument is flush and square with the front of the rack and tighten the fixing screws.
6. Insert the analog and alarm connectors into their respective sockets on the rear of the instrument (refer to Section 2.5) and connect the external PRT probe and USB communications cable and connector as appropriate.
7. Connect the power supply cable and switch the ON/OFF switch to ON.
8. Refit any covers to the rack as necessary.

To remove from the rack follow the directions above, in reverse.

2.5.10 Fitting the Safety Strap

WARNING
A safety strap must be equipped when the instrument is operating at pressures higher than 14.5 psig (1 barg)

The purpose of the safety strap is to secure both over-center locking bars in position to prevent them from being unexpectedly disengaged from the sensor housing. If the strap is not installed, the sensor housing could spring open causing damage to the instrument.

On both high pressure models, the safety strap is installed as follows (refer to *Figures 16 and 17)*:

1. Insure that the sensor chamber is at atmospheric pressure before pulling out the blanking plug (1) from the sensor housing.
2. Insure that both over-center clamps (2) are vertical (locked) and locate the two eyes (3) in the safety strap, one over each locking bar, and push the plug (4) fully into the microscope fixing hole.
3. Lock the safety bar into position by rotating the locking screw (5) clockwise.

Safety strap removal

1. Insure that the sensor chamber is at atmospheric pressure.
2. Rotate the locking screw (5) counter clockwise and lift off the safety strap.

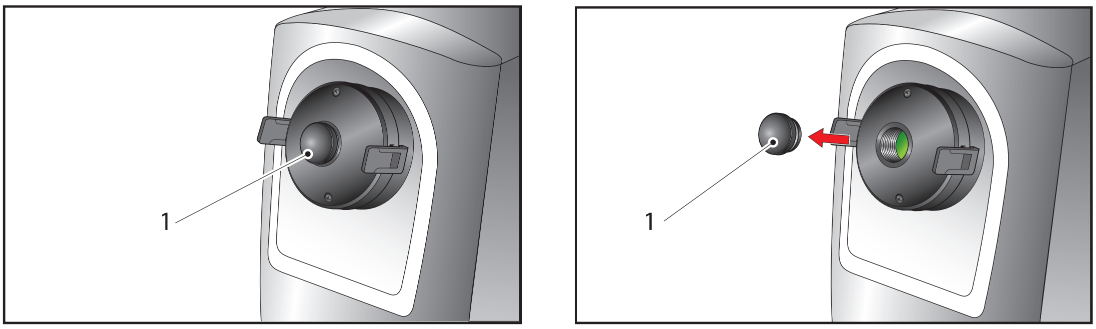


Figure 16 *Removing the Blanking Plug*

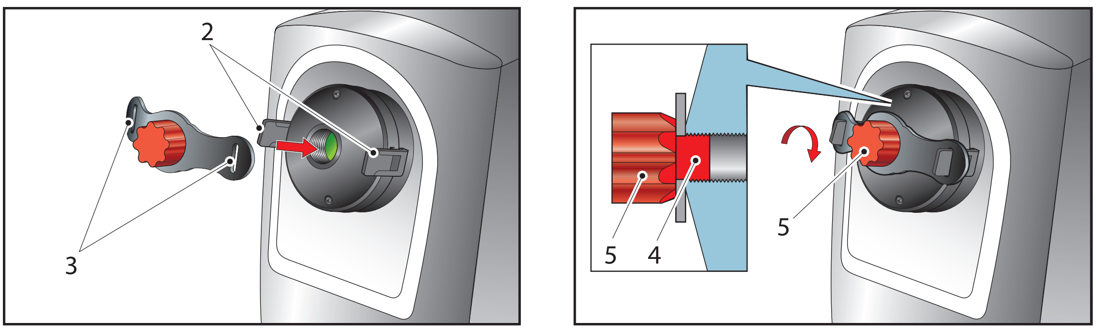


Figure 17 *Fitting or Removing the Safety Strap*

3 OPERATION

As supplied, the Optisure is ready for operation and has been set-up with a set of default parameters. This section describes both the general operation of the instrument and the method of setting it up and changing the default parameters should this become necessary.

Before operating the instrument read this section, which describes the operation of the instrument's controls and explains the display functions in detail.

Prior to operation the instrument must have been connected to a sample gas supply as detailed in Section 2.5.7, the correct electrical power supply and the relevant analog and alarm outputs connected to external systems as described in Section 2.

On delivery the instrument will have been set-up with a standard set of default parameters defining the operation of the instrument. These parameters can be changed as required by means of the **SETUP** Menu (refer to Section 3.6.4).

3.1 General Operational Information

Operation of the Optisure hygrometer is completely automatic and, once set-up for a measurement cycle, requires little or no operator intervention.

While the instrument can physically operate in a flowing gas stream of between 0.6 and 2.1 scfh, (0.3 and 1 Nl/min), Kahn Instruments recommends operating at 1.06 scfh (0.5 Nl/min) which is the flow-rate used during calibration. Operating at an alternative rate could impact the instrument's response time.

For all applications, the sample gas is taken into the instrument via the **GAS IN** port located on the front panel, from where it passes into a sample chamber. The gas flow rate is then measured on the exhaust side of the sample chamber, prior to being exhausted from the instrument via the **GAS OUT** port. The sample gas flow rate is not controlled within the instrument. If necessary this must be controlled outside the instrument, typically by means of a needle valve located at the input.

Within the sample chamber, the gas is passed over a Peltier chilled, gold-plated mirror. The instrument's internal control system maintains the drive to the Peltier heat pump to insure, by controlling the mirror temperature, that a level of condensate is maintained on the mirror surface. The temperature of the mirror is then measured as the dew point.

After passing over the mirror, the sample gas is then typically exhausted to atmosphere via the **GAS OUT** port. Using this configuration, dew-point measurements are taken at atmospheric pressure.

The sampling chamber is available in two different configurations; low pressure and high pressure. The low pressure version is designed to operate up to 14.5 psig (1 barg) max and the high pressure version up to 250 psig (17 barg) max. When operating in high pressure applications, a relevant gas sample line, representative of the product, would be taken and fed into the instrument. The output port would, in these applications, be connected to a suitable high pressure exhaust line. The gas flow would also need to be regulated externally on the output port of the instrument to maintain it within the instrument's operational limits.

The Optisure is suitable for the measurement of moisture content in a wide variety of clean, non-corrosive gases. It will not contaminate high purity gases and is safe for use in critical semi-conductor and fiber optic manufacturing applications.

3.2 Function Keys

The function keys, located below the display on all models, are used to select operations from the **MAIN** menu level, to enter sub-menu levels and to select and enter parameter variables within those menu levels.

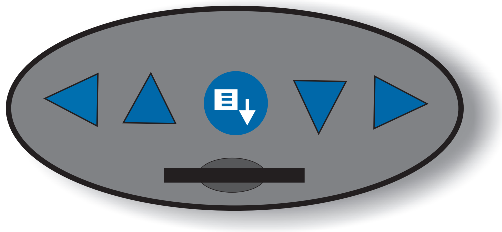


Figure 18 *Function Keys*

The SD card reader, used for data storage during data logging operations, is located below the function keys.

3.2.1 Up and Down Arrow Keys

The ▲ (up) and ▼ (down) keys are used to scroll through menus and adjust values.

3.2.2 Left and Right Arrow Keys

The ◀ (left) and ▶ (right) keys are used to scroll through alternative parameters within the highlighted panes on the **FRONT** page.

The ◀ (left) key is also used to step back one menu level.

3.2.3 Enter or Select Key

The (enter) key is used to move from one sub menu down to the next level.

The (enter) key is also used to select highlighted options in order to change parameter variables within these options.

3.3 Instrument Display

For all models of the instrument the display and the associated function keys form the operator interface.

FRONT Page

Figure 19 shows a typical **FRONT** page display while the instrument is running in **MEASURE** Mode.

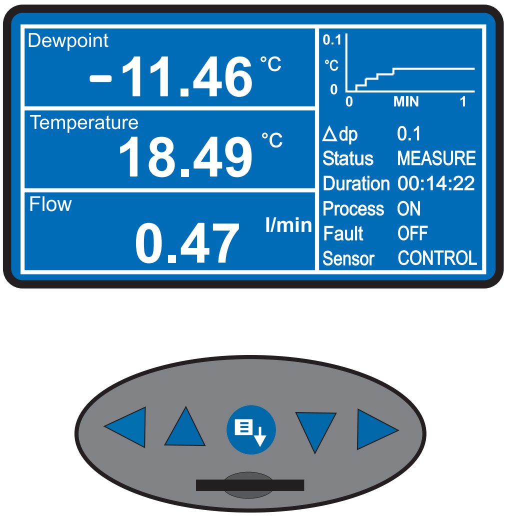


Figure 19 *Typical Front Page Display*

The instrument display is divided into two sections.

Operational data (measured, or data calculated from measured parameters) is shown in the three horizontal panes on the left hand side.

Operational status information is shown in a separate display area on the right hand side.

3.3.1 Operational Data Display

Each of the three operational data panes can be configured to display one of the following parameters:

1. Dew point
2. Temperature
3. Water content (ppm_V)
4. Water content (ppm_W)
5. Water content (g/kg)
6. Water content (g/m^3)
7. Pressure (see also Section 3.7)
8. Flow rate
9. % Relative humidity, %RH
10. Temperature difference

The parameters displayed are operator selectable and, by default, are set (from the top of the display) to Dew point, Water Content (ppm_V) and Flow.

To change one of the displayed parameters follow the instructions below (see *Figure 20)*.

1. Press the ▼ (down) key to highlight the top pane.
2. Use a combination of the ▼ (down) and ▲ (up) keys to highlight the required pane.
3. Use a combination of the ◀ (left) and ▶ (right) keys to scroll through the list of parameters available for display. **NOTE: A parameter can only be displayed on screen once. If it is already displayed, it is not available for display in a second panel on the same screen.**
4. When the required parameter is displayed, press the key. The display will now show an updated **FRONT** page.

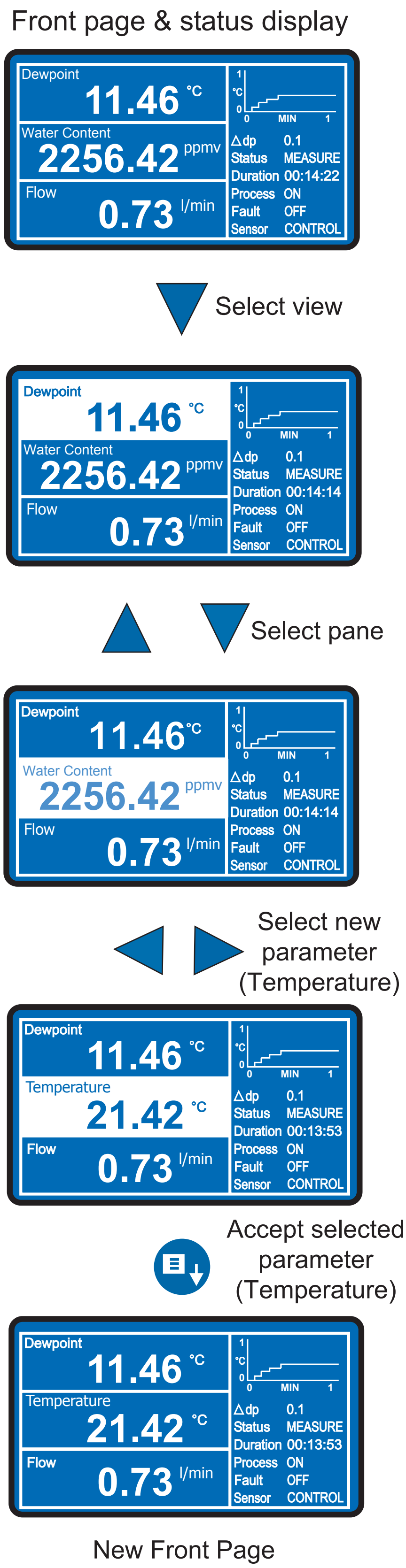


Figure 20 *Set-up Display*

3.3.2 Operational Status Display

The Status Display is shown on the right hand side of the screen and details the following:

1. **Stability graph** - shows measured dew point over a user-optional duration. This time variable (Stability Time), is set-up within the **DISPLAY** option of the **SETUP** Menu (refer to Section 3.6.4).
2. **Δ dp value** - represents the change in dew point over the stability duration as shown on the graph.
3. **Status indicator** - reports which operational phase the instrument is currently in. This will be either **DCC**, **HOLD**, **MEASURE** or **MAXCOOL**.
4. **Duration indicator** - reports back the time (in Hours:Minutes:Seconds format) remaining in the phase currently being displayed in the Status indicator.
5. **Process -** this two state **ON/OFF** notification indicates whether a parameter process alarm is either **ON** or **OFF**. A process alarm can be set on any parameter and its set-point. The **ON/OFF** control is set-up via the **SETUP** Menu (refer to Section 3.6.4).
6. **Fault** - used to monitor the optical system and the degree of mirror contamination. During normal operation, when there are no fault conditions, this will read **OFF**. It will be set to **ON** if there is either a fault with the optics or dp temperature measurement or if the mirror contamination exceeds 100% of the film thickness, indicating that the mirror needs to be cleaned. Refer to Section 5.4 for mirror cleaning.
7. **Sensor** - indicates the operational mode of the sensor. This can be either **CONTROL**, **HEATING** or **COOLING**.

3.4 Menu Structure

The Optisure has a three level menu structure, the top level of which (**MAIN** Menu), is accessed from the **FRONT** page by pressing the key.

The **MAIN** Menu will pop-up and overwrite the central area of the current display, as shown in *Figure 21*. Within this pop-up menu, five options are available: **EXIT, DCC ON/OFF, MAXCOOL/MEASURE, STANDBY/OPERATE** and **SETUP**.

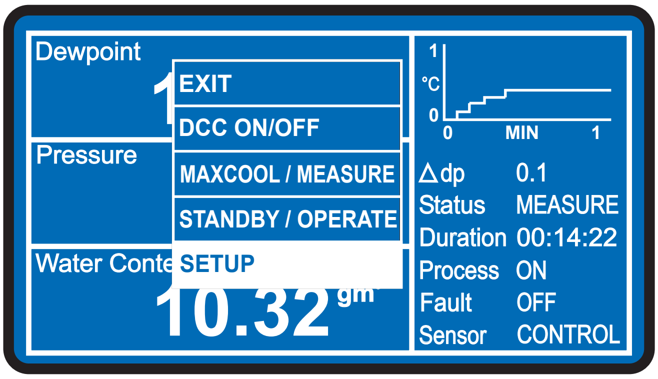


Figure 21 *Main Menu*

These options are selected by means of the ▲ (up) and ▼ (down) keys. Pressing the key provides access to the operations associated with that option.

Selecting the **EXIT** option returns the operator to the **FRONT** page.

The next three options, **DCC (ON/OFF), MAXCOOL/MEASURE** and **STANDBY/OPERATE** are two-state, context-sensitive, instrument control commands. These are toggled from one state to another by means of the key. For example, if **DCC** is ON, **DCC OFF** is displayed in the **MAIN** Menu. Operation of the key will toggle **DCC** to OFF and the menu will display **DCC ON**. Section 3.6 describes the operations of these functions.

The **MAXCOOL/MEASURE** and **STANDBY/OPERATE** options operate in a similar manner, displaying the only option available on the **MAIN** Menu.

When the **SETUP** option is highlighted, pressing the key provides access to a second menu level, the **SETUP** Menu page. The **SETUP** Menu page and the third level **VARIABLES** pages are presented as full page screens.

The options on the **SETUP** Menu page are scrolled by means of the ▲ (up) and ▼ (down) keys. Pressing the key, when an option is highlighted, provides access to the associated third level **VARIABLES** page.

Within the third level **VARIABLES** pages, the ▲ (up) and ▼ (down) keys are used to scroll through the individual fields. Pressing the key enables editing. The ▲ (up) and ▼ (down) keys are used to change the parameter values. Operation of the key sets the selected value into the appropriate field.

In the **VARIABLES** pages, pressing the ◀ (left) key returns to the **SETUP** Menu.

In the **SETUP** Menu, selecting the **EXIT** option followed by operation of the key, returns to the **FRONT** page.

Once the setup parameters have been fixed, only **MAIN** Menu operations tend to be used on a daily basis.

Details of the setup parameters and their default values can be found in Section 3.6.4.

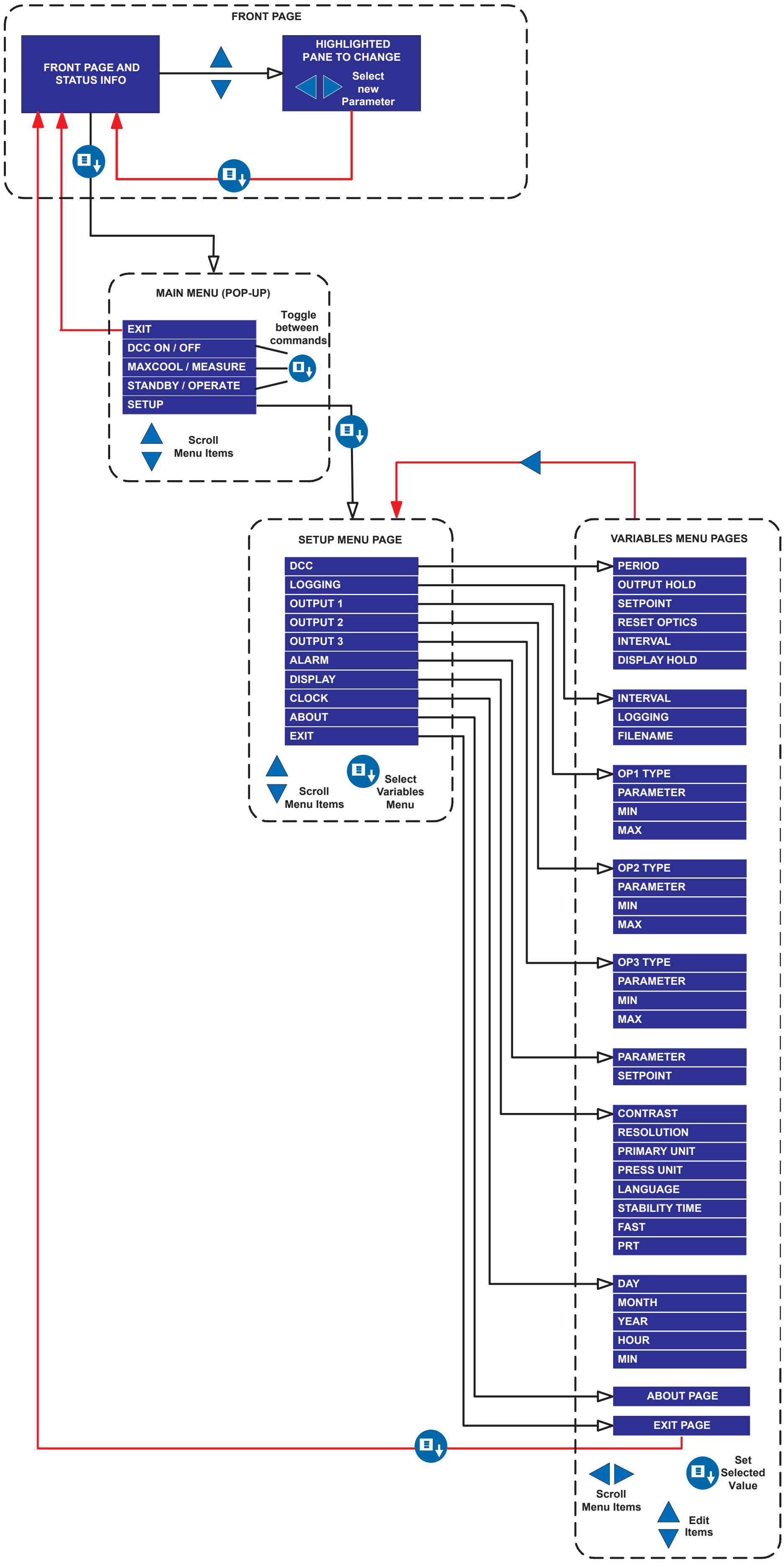


Figure 22 *Menu Structure*

3.4.1 Operating Cycle

The default parameters set-up for the instrument define an operating cycle, see *Figure 23.*

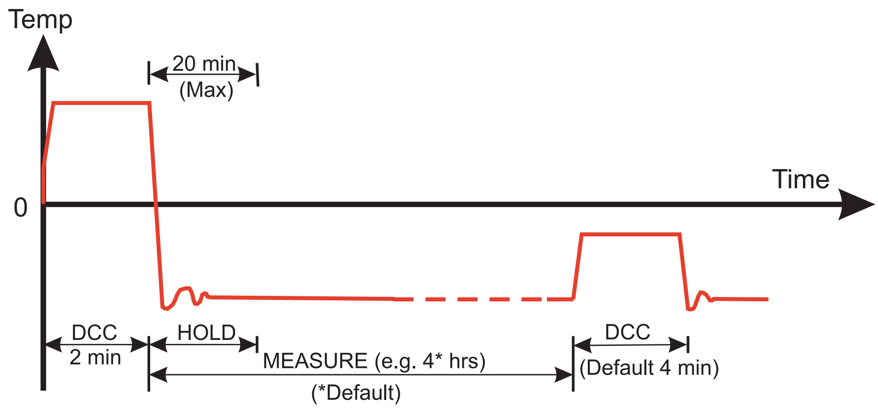


Figure 23 *Typical Operating Cycle*

At initial switch-on, the instrument enters a DCC cycle for 2 minutes. This heats the mirror 36°F (20°C) above the previously measured value - at the time of switch on this will be 36°F / 20°C above the ambient temperature. This Insures that all moisture is driven off the surface of the mirror.

The mirror is maintained at this temperature for the DCC duration (default 4 minutes or 2 minutes at switch-on). During the DCC process, Data Hold fixes the analog outputs at the value(s) read before DCC commenced. Data Hold typically lasts 4 minutes from the end of a DCC cycle, or until the instrument is measuring a stable dew point. This procedure is in place to prevent any system which is connected to the outputs from receiving a 'false' reading.

After the DCC period has finished, the measurement (**MEASURE**) period commences, during which the control system decreases the mirror temperature until it reaches the dew point. The sensor will take a short amount of time to settle on the dew point. The length of this stabilization time depends upon the temperature of the dew point. When the measurement is stable the Sensor area of the display will indicate **CONTROL**.

The end of a DCC cycle re-sets the interval counter, meaning that another DCC will start (by default) in 4 hours time. Once the measurement is stable, **HOLD** will release, and the analog outputs will resume their normal operation. At this point the **STATUS** area of the display will change to **MEASURE**.

At the end of the measurement (**MEASURE**) period, another DCC cycle commences and the process repeats.

3.5 First Time Operation - Operate Mode

OPERATE mode is the normal setting of the Optisure for dew-point measurements. To commence operation, proceed as follows:

1. Switch on the instrument by means of the Power **ON** switch located on the rear panel of the instrument. **NOTE: Rack mounted models will be turned on when the rack power supply is switched on.** The instrument display will now come on, typically showing the default parameters and units as detailed in *Figure 24*.

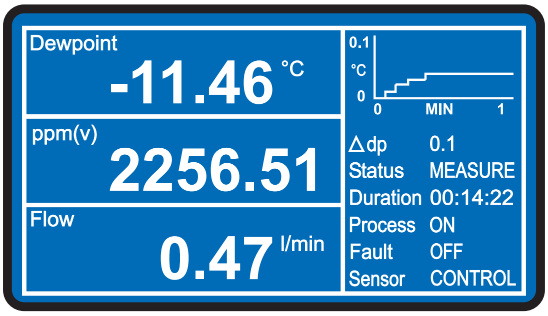


Figure 24 *Main Display*

2. Check that the sample flow rate is within the operational limits (0.5 Nl/1.0 scfh min ±0.2 Nl/ ±0.4 scfh min). If flow rate is not configured as a displayed default parameter, change one of the default panes to show Flow Rate.
3. Adjust the external flow control valves to achieve the required flow rate.
4. Set up the display to show the required parameters as detailed in Section 3.3.1.
5. The instrument is now operational and at the end of a 2 minute initial **DCC** period, will switch to a **MEASURE** cycle as described in Section 3.4.1.

The instrument will now be operating using the default parameters which are as shown in Table 3. Section 3.6.4 describes the method of changing these set-up parameters.

3.6 Operating Functions

This section describes the **DCC**, **MAX COOL**, **STANDBY** and **SETUP** functions that are initiated through the **MAIN** Menu.

The **MAIN** Menu can be accessed from the **FRONT** page by pressing the key. The options are accessed by then pressing the ▲ (up) and ▼ (down) keys.

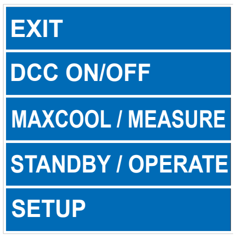


Figure 25 *Main Menu Display*

3.6.1 DCC - Dynamic Calibration Control

A manual **DCC** can be initiated or cancelled by selecting the **DCC** command from the **MAIN** menu. The **DCC** command is context sensitive, i.e. if **DCC** is **ON**, the **MAIN** menu shows **DCC OFF** as being selectable. Similarly if **DCC** is **OFF**, **DCC ON** is shown.

Dynamic Contamination Control (**DCC**) is a system designed to compensate for the loss of measurement accuracy which results from mirror surface contamination.

During the **DCC** process the mirror is heated to a default temperature of 20°C above the dew point to remove the condensation which has formed during measurement. The surface finish of this mirror, with the contamination which remains, is used by the optics as a reference point for further measurements. This removes the effect of contamination on accuracy.

After switch-on, the mirror is assumed to be clean, therefore the instrument will only run a **DCC** for 2 minutes to quickly establish a clean mirror reference point. By default, every subsequent **DCC** is 4 minutes in duration and will automatically occur every 4 hours.

At certain times it may be desirable to disable the **DCC** function in order to prevent it from interrupting a measurement cycle, e.g. during a calibration run.

Refer to Table 3 for a description of the parameters that can be changed relating to the **DCC** cycle.

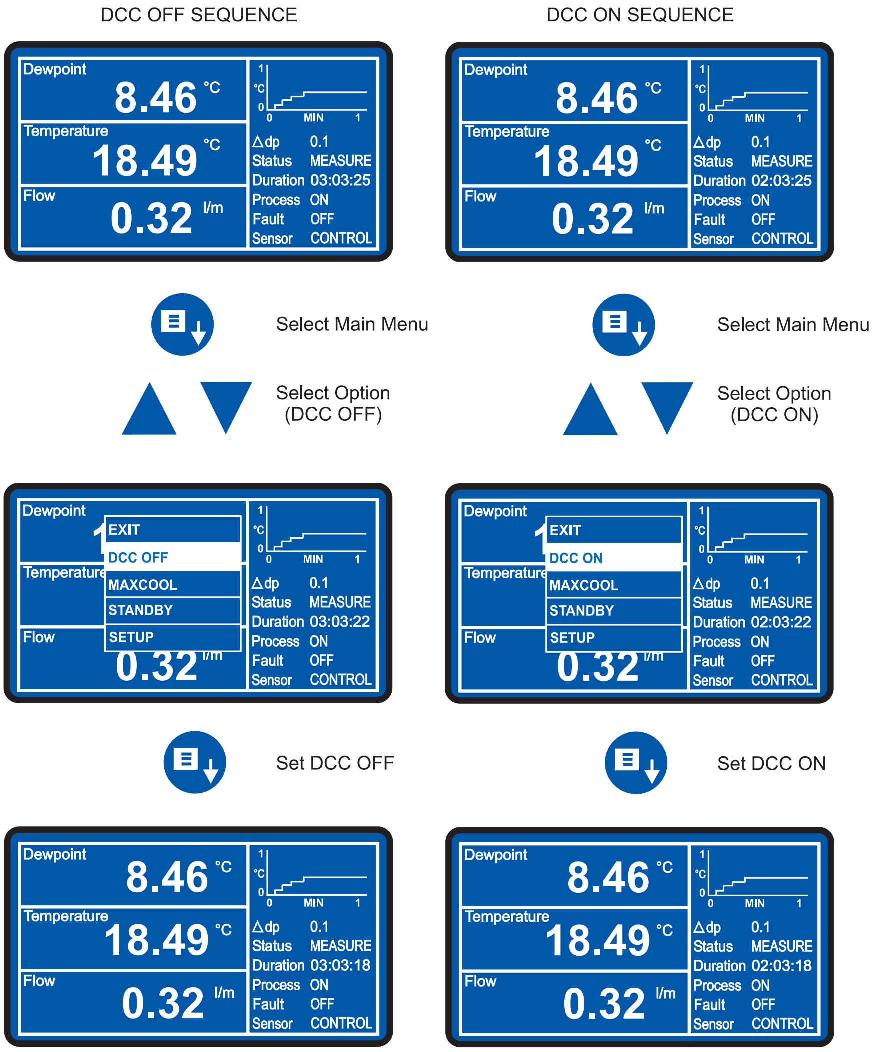


Figure 26 *DCC ON/OFF*

3.6.2 MAXCOOL Function

The **MAXCOOL** function over-rides the dew-point control loop and applies maximum cooling drive to the Peltier heat pump. It can be used:

- to determine what temperature the mirror can be driven down to with reference to the sensor body. This temperature is indicated on the display.
- to determine whether or not the instrument is controlling at the dew point and whether it is able to reach it. This situation could, for instance, arise when attempting to measure very low dew points where, possibly due to a high ambient temperature, the Peltier heat pump is unable to depress the temperature far enough to reach the dew point.
- to determine whether the instrument is controlling - this can be checked by switching **MAXCOOL** on for a short period and then back to **MEASURE**. This will depress the mirror temperature briefly and when it is switched back to **MEASURE**, the control loop should be able to stabilize the mirror temperature at the dew point again.

Figure 27 shows the method of switching the **MAXCOOL** facility ON and OFF.

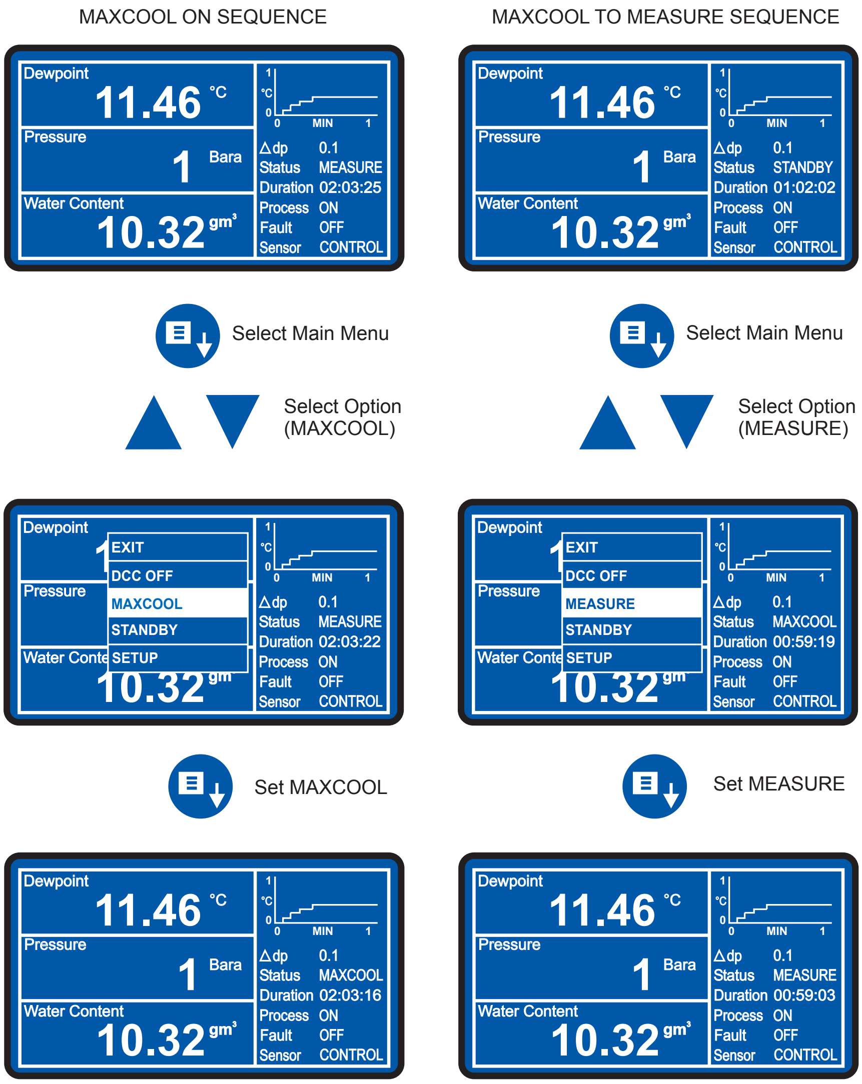


Figure 27 *Switching MAXCOOL and MEASURE Mode*

3.6.3 STANDBY Function

This function is used for applications where the dew point of the sample gas changes very quickly from dry to wet, creating conditions which may cause the sensor to saturate. Alternatively it may be used in applications requiring infrequent manual measurements to be taken, where it is preferable to have the sensor disabled between measurements.

In **STANDBY** mode, drive to the Peltier heat pump is removed, allowing the sensor to settle naturally at the ambient temperature and so eliminate the possibility of sensor saturation.

The main use for this feature is during set-up, for instance where flow rates are being adjusted and the analog outputs are being configured, where measurements are not required during this period.

This feature is also used to inhibit **MEASURE** mode while the mirror is being cleaned.

Figure 28 shows the method of selecting and cancelling **STANDBY** mode. **NOTE: When switching from STANDBY to OPERATE mode, a DCC cycle will be initiated.**

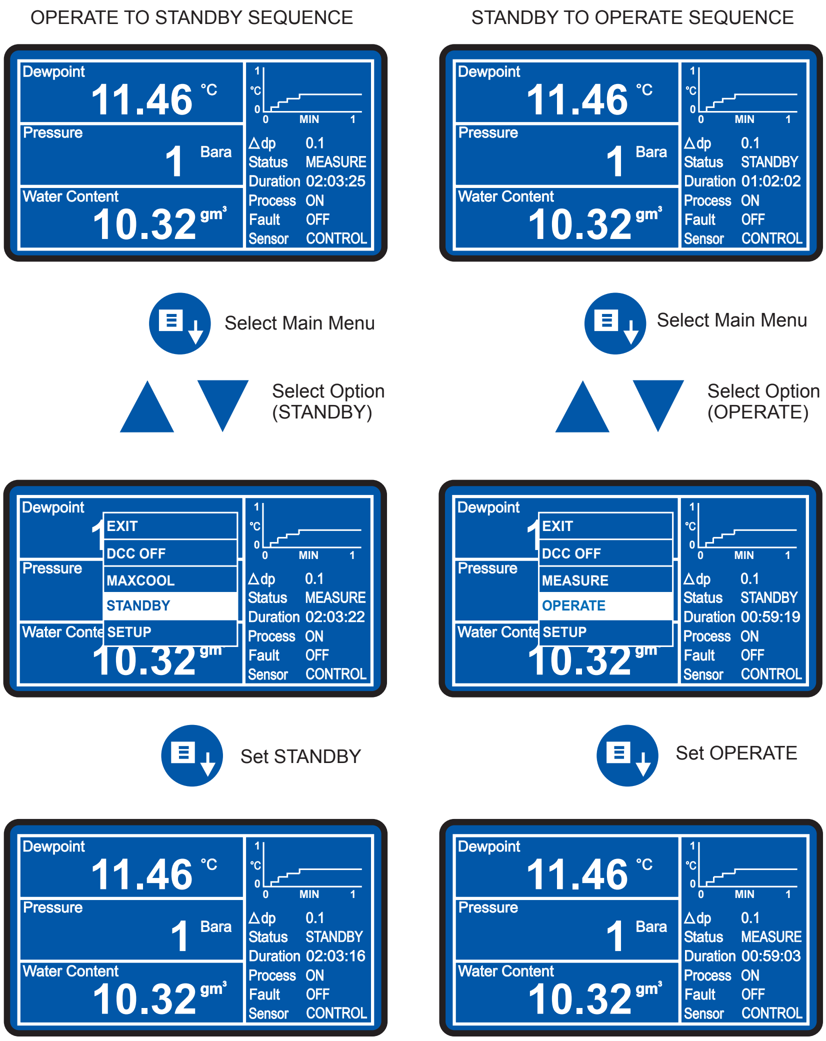


Figure 28 *Switching STANDBY and OPERATE Mode*

3.6.4 SETUP Menu

SETUP menu is used for changing system control parameters or activating the built-in data logging.

The **SETUP** menu can be accessed from the **MAIN** menu, using the ▼ (down) key, and then pressing the key. *Figure 29* shows the key sequence.

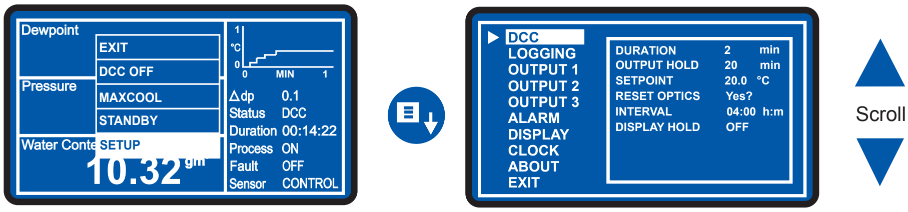


Figure 29 *Set-up Menu Selection*

Initially, when the **SETUP** menu is opened, **DCC** is highlighted and all the data fields relating to **DCC** are shown, together with their current settings. For first time operation, these will be the default settings relating to **DCC**.

To select any of the other sub menus use the ▲ (up) and ▼ (down) keys to scroll through the list.

Any highlighted sub-menu can be accessed by pressing the key.

This highlights the first item of the sub-menu. The ▲ (up) and ▼ (down) keys can be used to scroll though the other items in the sub-menu.

Press the key to edit the value of the selected item. The value will be highlighted to indicate editing is in progress.

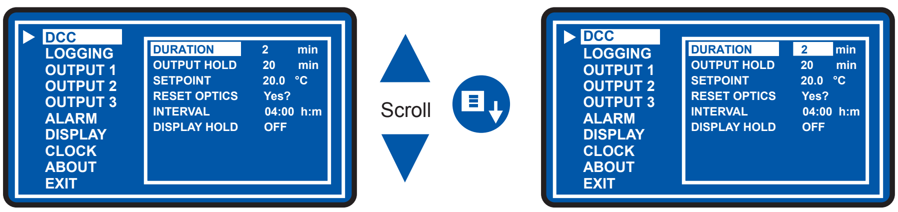


Figure 30 *DCC Sub-Menu Selection*

The value can be changed using the ▲ (up) and ▼ (down) key. To finish editing and accept the new value press the key.

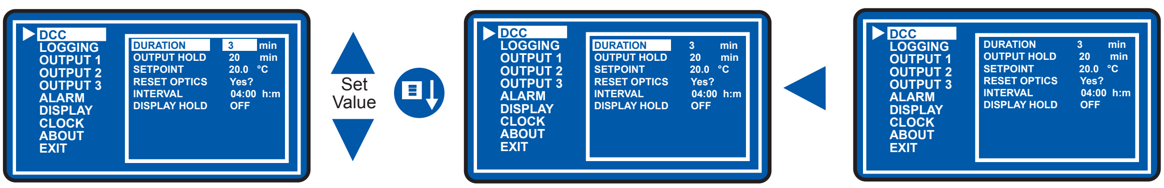


Figure 31 *Set Parameter Value*

To return to the **SETUP** menu, from any part of the sub-menu list, press the ◄ (left) key (see *Figure 31)*. To return to the **MAIN** menu from the **SETUP** menu, press the ◄ (left) key, highlight **EXIT** and press the key

Function	Field	Setting	Unit	Remarks
DCC	DURATION OUTPUT HOLD SETPOINT RESET OPTICS INTERVAL DISPLAY HOLD	4 20 20 Yes? 04:00 NO	min min °C/°F h:m	Duration of the **DCC** cycle. Maximum output hold time after **DCC**. No. degrees heated above mirror temp. Resets optics signal level during next **DCC** cycle. Sets duration of **MEASURE** period before next **DCC** cycle If set to YES, display readings are held during **DCC** & **HOLD** period. If set to NO, display always tracks measured parameters.
LOGGING	INTERVAL LOGGING FILENAME	5 No N/A	sec	Interval between consecutive log points. Set to YES to start logging, set to NO to finish logging and close current log file. Automatically added when logging started.
OUTPUT 1	OP1 TYPE PARAMETER MIN MAX	4-20 DP -60 +40	mA °C/°F °C/°F	Output signal type (4-20 mA, 0-20 mA or 0-1 V). Output parameter monitored (list of 10). Upper span limit. Lower span limit.
OUTPUT 2	OP2 TYPE PARAMETER MIN MAX	4-20 ppmV 0 3000	mA ppmV ppmV	Output signal type (4-20 mA, 0-20 mA or 0-1 V). Output parameter monitored (list of 10). Upper span limit. Lower span limit.
OUTPUT 3	OP3 TYPE PARAMETER MIN MAX	4-20 Flow 0 1000	mA ml/min ml/min	Output signal type (4-20 mA, 0-20 mA or 0-1 V). Output parameter monitored (list of 10). Upper span limit. Lower span limit.
ALARM	PARAMETER SETPOINT	DP 0		Process parameter to be monitored. Process alarm trigger point.
DISPLAY	CONTRAST RESOLUTION PRIMARY UNIT PRESS UNIT LANGUAGE STABILITY TIME FAST PRT	75 2 ENG 1 ON INT	 % °C bara English min	Contrast level - adjust to suit. Display resolution. Temperature unit (°C or °F). Pressure unit (if sensor equipped). Display language. Time scale for stability graph. Frost Assurance facility ON/OFF.
CLOCK	MONTH DAY YEAR HOUR	NOV* 10* 07* 16:45*	 h:m	Adjust to local time as required. Set to local time and date at despatch. **** Note: Current time (example only)***
ABOUT	Software issue information			Displays current Instrument and display firmware issue details (for information only)
EXIT				Select to quit to main display

Table 3 Default Set-Up Parameters

3.7 Pressure Measurements

As an option, the Optisure instrument can be equipped with an internal pressure sensor that measures the sample gas pressure. If equipped, this option allows for the on-line measurement and monitoring pressure of the sample gas.

The pressure measured by this sensor is then used internally as the basis for compensation for the calculation of all the pressure related parameters, ppm$_{V,}$ ppm$_{W}$, g/m^3 and g/kg.

If a pressure transducer is not equipped 101.3 kPa is used as the basis of all these calculations. The internal pressure transducer is ranged 0 to 377 psia (0 to 25 bara).

The displayed pressure units can be changed from the Display sub-section of the Setup Menu. The option **PRESS UNIT** can be set to psia, bara, KPa or MPag.

3.8 Logging Function

WARNING
Insure logging is stopped through the Logging Menu before powering off the instrument or all logged data will be lost.

The **LOGGING** function provides the facility to log, at operator specified intervals, real-time values of all the instruments' parameters and to store these logged results on an SD memory card.

To set-up this facility, proceed as follows:

1. Select **SETUP** from the **MAIN** menu and press the key to display the **SETUP** menu.
2. Press the ▼ (down) key to highlight **LOGGING** and press the key twice to enter e.g. the **INTERVAL** field.
3. Use the ▲ (up) and ▼ (down) keys to set the required **INTERVAL** duration and press the key.
4. Insert a formatted SD card in the slot immediately below the function keys. Refer to Appendix B for details on formatting an SD card.
5. Press the ▼ (down) key to highlight **LOGGING** and press the key to enter the selection field (which initially will be set at NO).
6. Press the ▼ (up) key to select Yes and press the key. NOTE: If an SD card has not been installed, it will not be possible to select Yes and an error message **CARD NOT Equipped!** will be displayed.
7. A file name, based on time/date is automatically allocated and will be written into the File name field as soon as an SD card is inserted.
8. Quit the **SETUP** menu by using the ◀ (left) key, selecting **EXIT** and pressing the key.

Refer to Appendix B for information on how to correctly format SD cards.

3.9 FAST - Frost Assurance Technology

Theoretically, it is possible for water to exist as a super-cooled dew formation below +32°F (0°C) and, typically, can be encountered at temperatures down to -40°F (-40°C).

Since the vapor pressure of a gas in equilibrium with a condensate is higher for water than it is for ice, a chilled mirror hygrometer measuring a super-cooled dew point below +32°F (0°C), but assumed to be at a frost point, will actually show a dew-point temperature which is approximately 10% lower than the actual frost point temperature.

When turned on, the Optisure's **FAST** system identifies that the measured dew point is between -40°F (-40°C) and +32°F (0°C) and automatically decreases the mirror temperature until a pre-determined film thickness of condensate is detected, thereby ensuring a guaranteed frost formation. The mirror temperature is then increased to above the initial measured dew point, but maintained below +32°F (0°C), and the excess condensate driven off the mirror. The system then controls for dew point based on the frost formation.

Once ice has formed it will remain as ice until the temperature is raised above +32°F (0°C). This means that the state of the condensate on the mirror must be a frost formation and the dew point of the gas can be measured with increased accuracy and reliability.

If required, the instrument's **FAST** function can be switched on and off from the Display option in the **SETUP** menu.

3.10 External PRT

If required either for the calibration process, or for external monitoring, the instrument's internal **PRT** can be made available for external connection as follows:

1. Select **SETUP** from the **MAIN** menu.
2. Use the ▼ (down) key to select **DISPLAY** from the **SETUP** menu.
3. Press the key to enter the **DISPLAY** option and then use the ▼ (down) key to highlight **PRT**.
4. Press the key to enter the **PRT** parameter field and use either the ▲ (up) or ▼ (down) key to change the parameter field to **EXT**. **NOTE: The instrument must be in a** MEASURE **phase, not** DCC **or** DATAHOLD.
5. Press the key to set the **PRT** to **EXT**. **NOTE: When set to** EXT PRT **mode,** DCC **is inhibited, the dew-point temperature display will read 0.00, and the status graph display is not functional.**
6. Press the ◀ (left) key to return to the **SETUP** menu. Press the ▼ (down) key to highlight **EXIT**, then press the key to quit the **SETUP** menu.
7. To return the instrument to internal monitoring, repeat operations 1 to 6 above, selecting **INT** at Step 4.

4 APPLICATION SOFTWARE

The Optisure Optical Hygrometer features a USB interface for communication with the application software. A copy of the application software is supplied on a CD with the instrument.

4.1 Installation

To install the application software on a PC, place the CD in the CD drive and run either the 32-bit or 64-bit setup file on the CD depending on your type of PC (i.e. run the 32-bit setup file if your PC is 32-bit, or run the 64-bit setup if your PC is 64-bit). If you are uncertain of your PC type, then right-click **Computer** in the Windows Start Menu. Click **Properties** in the pop-up menu. Your system type will now be displayed along with other information.

After you run either setup file, follow the application setup wizard displayed onscreen. If an authorization code is required during the installation process, please use **7316-KAHN-OPTI**

Once the setup wizard has finished, restart your PC to complete the installation.

4.2 Establishing Communications

When launching the application software, the Communications Setup screen will be displayed. The following sections explain how to establish communication with the Optisure Optical Hygrometer.

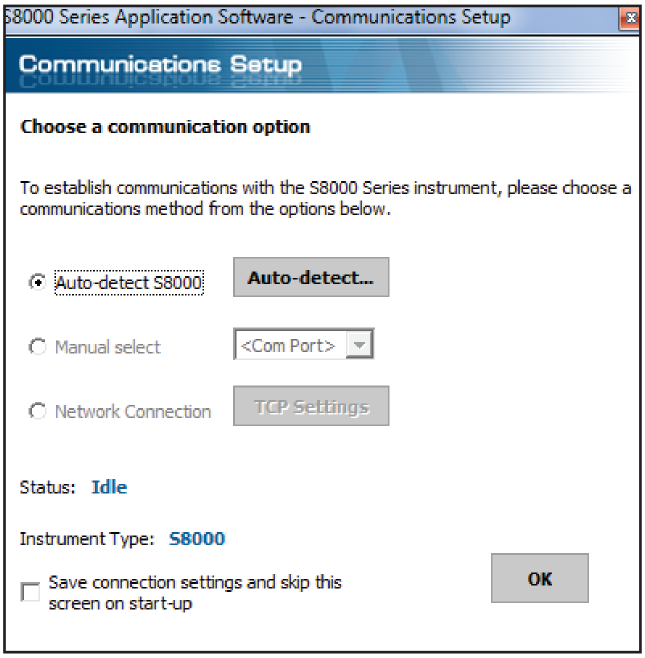


Figure 32 *Communications Setup Screen*

4.2.1 USB Communication

1. Connect the Optisure Optical Hygrometer to the PC using the supplied USB cable.
2. Windows will recognize the instrument and automatically install the relevant drivers. If the driver installation has been successful then the Windows Device Manager Screen will list the following driver (see *Figure 33)*:
3. Kahn Instruments USB to UART Bridge Controller
4. Launch the application software and choose one of the following types of connection:
5. **Auto Detect** – The application software will attempt to find the correct COM port automatically.
6. **Manual** – Choose the appropriate COM port from the drop down list, as shown in the Windows Device Manager Screen.
7. Click the **OK** button to proceed to the next screen.

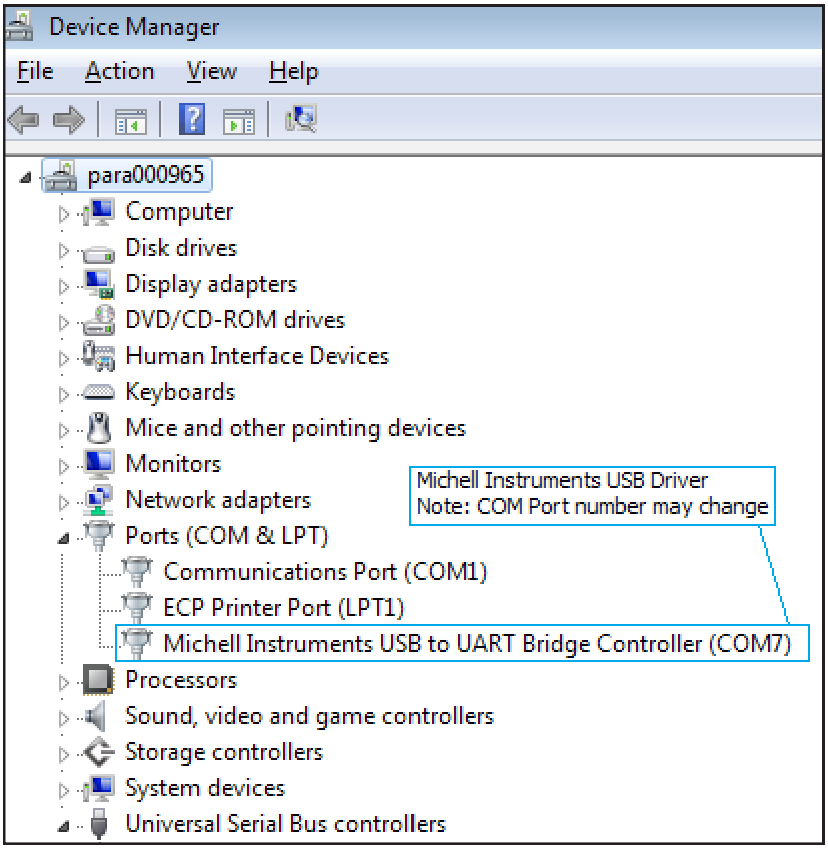


Figure 33 *Windows Device Manager Screen*

4.3 Data Acquisition or Edit Variables Mode

Once communication has been established, the Options Screen is displayed.

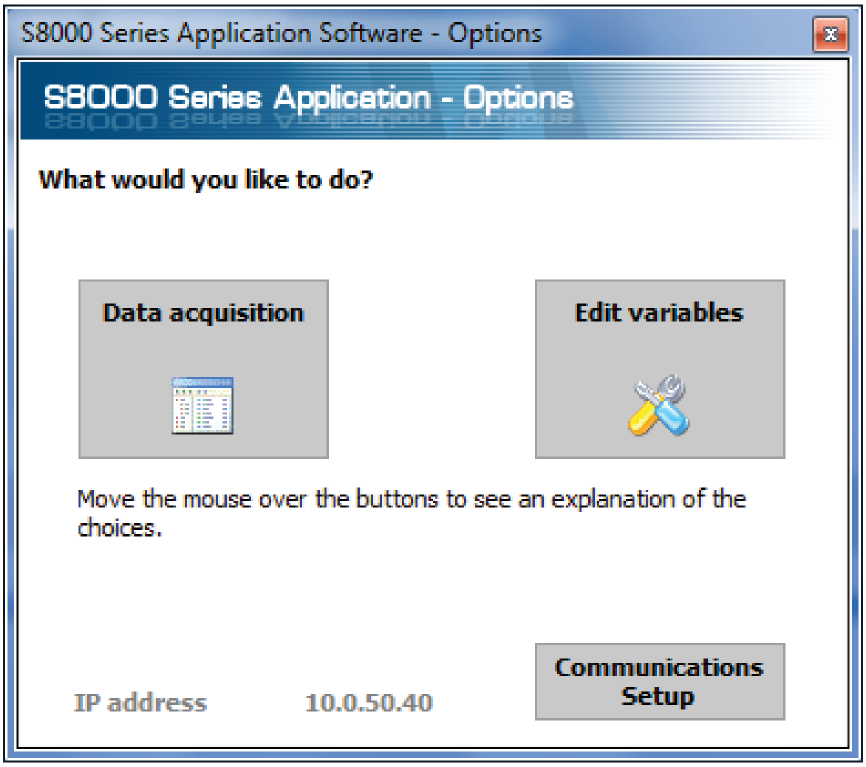


Figure 34 *Options Screen*

4.3.1 Data Acquisition

This mode of operation allows all measured instrument parameters to be graphed and logged in real time.

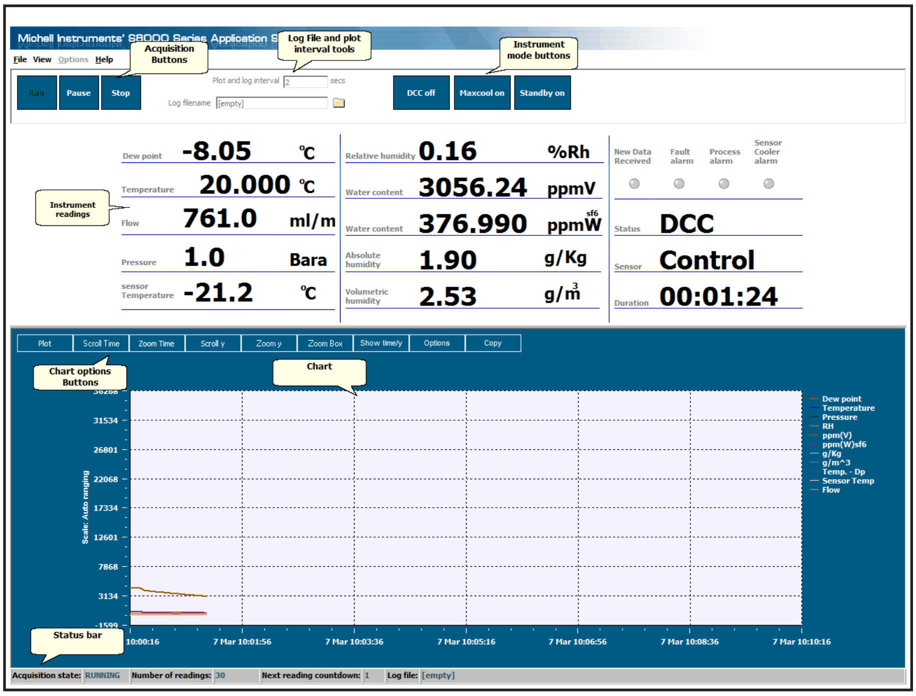


Figure 35 *Data Acquisition Screen*

Data Acquisition Control Toolbar

Name	Description
Run	Begin data acquisition and logging A filename must be first be selected to enable data logging
Pause	Pause data acquisition
Stop	Stop data acquisition
Plot and log interval	Time in seconds between graph and log file updates
Log filename	Path and filename of the log file Click the small folder icon next to this text box to create a new log file
DCC	Initiate a **DCC** cycle Refer to Section 3.6.1 for detailed information on the **DCC** function
Maxcool	Toggle between **MAXCOOL** and **MEASURE** mode Refer to Section 3.6.2 for detailed information on the Maxcool function
Standby	Toggle between **STANDBY** and **MEASURE** mode Refer to Section 3.6.3 for detailed information on the Standby function

Table 4 Data Acquisition Control Description

Instrument Readings and Status

This area displays all measured instrument parameters and shows the status of the Fault, Process and Sensor Cooler Alarms.

Graph Controls

Name	Description
Plot	Automatically advances the graph as new data is acquired
Scroll Time	Dragging the mouse on the graph scrolls along the time axis Drag to the left to scroll forwards Drag to the right to scroll backwards
Zoom Time	Dragging the mouse on the graph changes the scale of the time axis Drag to the left to increase the scale size Drag to the right to decrease the scale size
Scroll Y	Dragging the mouse on the graph scrolls along the Y axis Drag down to scroll up Drag up to scroll down
Zoom Y	Dragging the mouse on the graph changes the scale of the Y axis Drag up to increase the scale size Drag down to decrease the scale size
Zoom Box	Zooms in on both axes in the user selected area
Show time/Y	Select a parameter from the legend on the right hand side of the graph Dragging the mouse along the graph will move the vertical cursor along the time axis The Y value for the selected parameter at the position of the cursor will be displayed above the graph
Options	Displays the chart options window
Copy	Copies the chart to the clipboard as a bitmap file

Table 5 Graph Control Description

Graph

Plots the parameters selected by the user in the chart options window.

Status Bar

Name	Description
Aquisition state	Indicates whether data acquisition is running, paused or stopped, with the messages RUNNING, PAUSED or IDLE
Number of readings	Number of readings taken since starting the current acquisition session
Next reading countdown	Countdown timer (in seconds), which indicates when the next reading will be taken
Log file	Full path of the log file (if specified)

Table 6 Status Bar Description

4.3.2 Variable Edit

The variable edit mode allows the instrument configuration to be changed through the application software. On launch, it will automatically read and display the current values of each of the instrument variables.

NOTE: The variables are not periodically updated on-screen. To obtain up-to-date values, click the Read button.

Editing Variables

To edit a variable, first click on it to highlight it.

If the variable has a fixed list of options, a drop-down arrow will appear in the right-hand column. Choose a new value from the drop-down list provided.

If the variable does not have a fixed list of options, type the new value into the right-hand column text input area.

NOTE: The variable background colour will turn pink to indicate it has been changed on-screen and is pending upload to the instrument.

Click the Write button to upload changed values to the instrument.

NOTE: Variable values and formatting are checked by the application software before they are uploaded to the instrument.

A message box will report any errors found.

Once a modified value has been written to the instrument, the background colour will return to white.

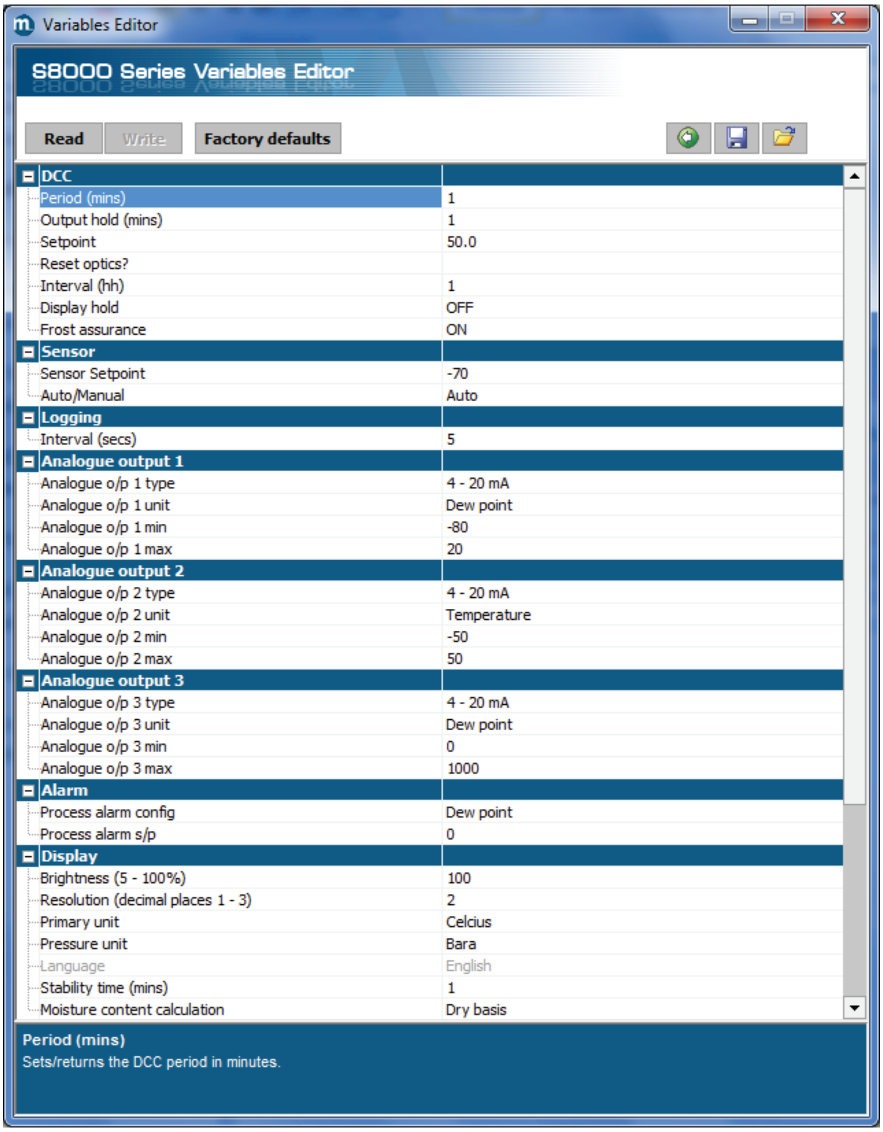


Figure 36 *Optisure Series Variables Editor Screen*

5 MAINTENANCE

There are no user-serviceable parts on the Optisure, other than cleaning the mirror in the sensor, the removal and replacement of the fan filter element and the removal and replacement of the AC power supply fuse.

5.1 Safety

This equipment operates from power supply voltages that can be lethal and at pressures (depending upon application) that could cause injury.

Insure that any test installation meets the standards described in Section 2.3 of this manual.

Under NO circumstances should the instrument case be removed or the air vents covered or in any way restricted.

Maintenance and repair, other than that described in this section, must only be carried out by trained personnel and the instrument should be returned to the manufacturer for this purpose.

5.2 Fuse Replacement

If the instrument fails to operate after it has been connected to an AC power supply (85 V to 264 V, 47/63 Hz) and switched on, proceed as follows:

1. If the power supply cable is equipped with a fused plug, switch off the power supply, remove the plug, check and, if necessary, replace the fuse. If the instrument still fails to operate, after fitting the fuse and switching the power supply on, proceed as follows (see *Figure 37)*.

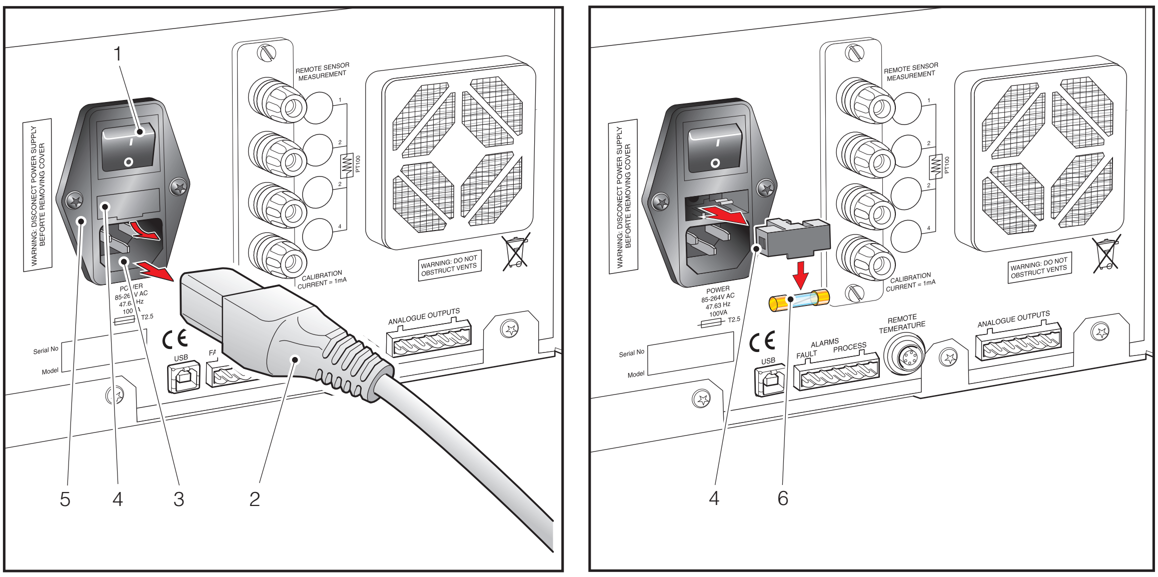


Figure 37 *Power Supply Fuse Replacement*

2. Switch the instrument's ON/OFF switch (1) to OFF, isolate the external power supply and remove the IEC power connector (2) from the instrument's power socket (3). **NOTE: If access to the rear of the instrument is restricted, e.g. if the instrument is a rack mounted model, it may be necessary to remove the instrument from the rack (refer to Section 2.5.9).**

3. Locate the fuse carrier (4) and pull it out of the connector housing (5). A small screwdriver inserted under the lip may be useful in order to lever it out.

4. Replace the fuse cartridge (6). **NOTE: It is essential that a fuse of the correct type and rating is equipped to the instrument (20mm, T-type (2.5A anti-surge).**

5. Fit a new fuse cartridge (6) into the fuse carrier (4) and push the fuse carrier (4) back into the power connector housing (5).

6. Push the IEC power connector (2) back into the power socket (3), turn on the external power supply and switch on the instrument (1). Check that the instrument is now operational. If the fuse blows immediately on switch-on either contact the manufacturer or their service agent. **DO NOT ATTEMPT ANY FURTHER SERVICING PROCEDURES.**

5.3 Fan Filter Cleaning

To maintain adequate cooling, it is essential that the fan filter be checked at periodic intervals and kept clean. The frequency of checking will depend upon the working environment but checking and cleaning at three-monthly intervals is recommended.

The fan is located on the rear panel of both vertical and horizontal models. *Figure 38* shows the method of removing the fan filter.

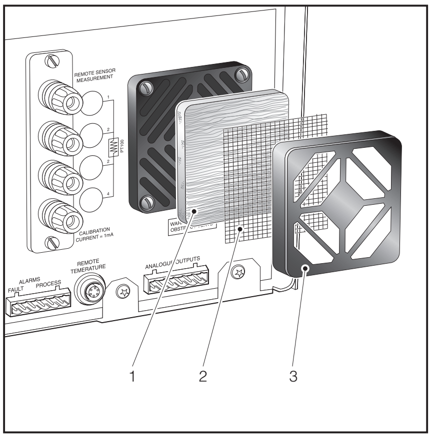


Figure 38 *Remove and Replace Fan Filter*

1. Switch off the instrument.

2. Grip the fan filter casing (3) and pull it away from the fan body. The casing is a push fit. If will not come away easily, there is a small slot located under the fan casing for the insertion of a screwdriver to assist in levering it off.

3. The fan casing (3) comes away with the gauze (2) and the filter element (1).

4. Clean the gauze (2) with a moist, lint-free cloth.

5. Wash the filter element (1) in water containing a mild detergent, rinse and allow to dry.

6. Clean the fan housing.

7. Fit the gauze (2) and the filter element (1) into the filter casing (3), and push the assembly back onto the fan housing until it clips into position.

5.4 Sensor Mirror Cleaning

WARNING
Before removing the safety strap or opening the sensor housing it is essential to vent the system to atmospheric pressure, otherwise severe injury or damage to the equipment could result.

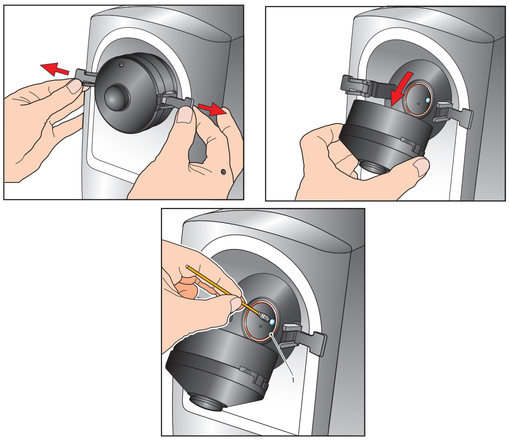


Figure 39 *Mirror and Optics Cleaning*

The cleaning procedure is as follows.

1. Switch the equipment to **STANDBY** mode (refer to Section 3.6.3), and allow sufficient time for the sensor to rise towards ambient temperature. **NOTE: DO NOT clean the mirror while its temperature is below zero otherwise the Q-tip will stick to the surface of the mirror (refer to the display for mirror temperature).**

2. Remove the safety strap (see Section 2.5.10).

3. Open the sensor housing to gain access to the mirror.

4. Soak a Q-tip in isopropyl alcohol and gently clean the surface of the mirror. To prevent scratching of the mirror surface, avoid pressing too hard on the Q-tip bud.

5. Allow the isopropyl alcohol solvent to evaporate off.

6. Clean the quartz window in the sensor cover with a fresh Q-tip bud.

7. Check that the O-ring seal (1) in the sensor housing is not damaged. If in doubt, remove and replace it. **NOTE: The integrity of the pressure seal between the sensor cover and the casing depends upon this O-ring seal.**

8. Close the sensor cover and lock it into position.

9. Cancel **STANDBY** mode and return the instrument to **MEASURE** mode. (Refer to Section 3.6.3).

5.4.1 Fitting the Microscope (Optional)

WARNING
The microscope must not be equipped when the instrument is operating at pressures higher than 14.5 psig (1 barg).

To observe the frost formation on the chilled mirror surface, an optional microscope (Part No. S8K-MCI) can be provided. The microscope allows direct viewing of the mirror surface, providing assurance that ice crystals have formed and that supercooled water is not present at temperatures below 32°F (0°C).

When the instrument is controlling at a dew point, condensation is seen as small, bright red specks against a dark background. Liquid water is seen as rounded droplets and ice as sharp edged crystals.

On both standard models, the microscope is equipped as follows (refer to *Figure 40).*

1. Pull out the blanking plug (1), or remove safety strap (see Section 2.5.10), from the sensor housing.
2. Initially, screw the microscope unit (2) into the sensor housing until about 6 threads remain showing.
3. If the instrument is not operating, switch it **ON** and rotate the microscope body until the mirror surface is brought into sharp focus. Two or three extra turns either way are usually sufficient.
4. To prevent stray light effects, always replace the blanking plug or safety strap after removing the microscope (refer to Section 2.5.10).

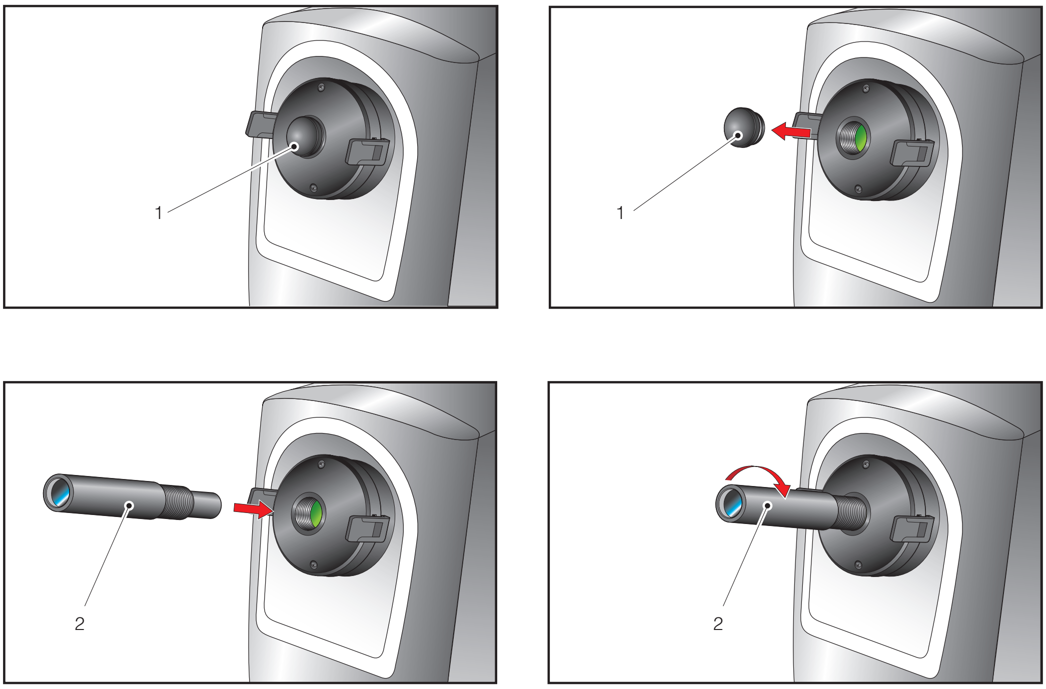


Figure 40 *Installing the Microscope*

6 GOOD MEASUREMENT PRACTICE

The Optisure is designed to operate in a flowing gas stream. The sampling chamber, which enables a small sample of gas to be passed over a Peltier chilled, plated copper mirror, is designed to operate at pressures up to 14.5 psig (1 barg) (low pressure version), and up to 250 psig (17 barg) max (high pressure version). For many applications, the sample chamber operates at atmospheric pressure with the sample gas being exhausted to atmosphere.

The sensor is designed for operation with flow rates of 0.6 and 2.1 scfh (0.3 and 1 Nl/min), although it will operate successfully at flow rates as low as 0.2 scfh (0.1 Nl/min). It is important to insure that the flow rate through the sample line, connecting the source to the Optisure, is high enough to avoid log time lags in response to humidity changes at the sample source.

Ideally therefore, the flow rate should be set between 0.6 and 2.1 scfh (0.3 and 0.7 Nl/min), 1.06 scfh (0.5 Nl/min) [±0.4 scfh (±0.2 Nl/min)] being the recommended optimum. For flow regulation purposes, by default, the **FRONT** page is configured to read **FLOW**. Should the **FRONT** page not be showing **FLOW**, Section 3.3.1 details the method of setting-up the instrument to display this parameter.

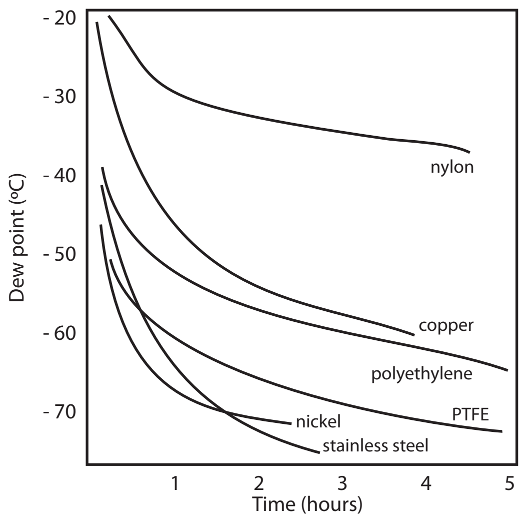
Flow regulation is not provided within the Optisure instrument. Gas flow must therefore be regulated outside the instrument, typically on the **GAS IN** side for atmospheric measurements, by means of a precision needle valve. Always use high quality valve gear, coupling connections and pipework.

Avoid pressure gradients in the system by placing excessive flow restriction on the **GAS OUT** side of the system. In applications where the test gas has a very high flow rate, an instrument by-pass arrangement is preferable to a flow restrictor after the sensor.

6.1 Sampling Hints

Measurement of moisture content is a complex subject, but does not need to be difficult. This section aims to explain the common mistakes made in measurement situations, the causes of the problem, and how to avoid them. Mistakes and bad practices can cause the measurement to vary from the expectation; therefore a good sampling technique is crucial for accurate and reliable results.

Transpiration and Sampling Materials



All materials are permeable to water vapor, as the water molecule is extremely small compared to the structure of solids, even when compared to the crystalline structure of metals. The graph above shows the dew point inside tubing of different materials when purged with very dry gas, where the exterior of the tubing is in the ambient environment.

Many materials contain moisture as part of their structure, particularly organic materials (natural or synthetic), salts (or anything which contains them) and anything which has small pores. It is important to insure that the materials used are suitable for the application.

If the partial water vapor pressure exerted on the outside of a compressed air line is higher than on the inside, the atmospheric water vapor will naturally push through the porous medium causing water to migrate into the pressurized air line. This effect is called transpiration.

Adsorption and Desorption

Adsorption is the adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to the surface of a material, creating a film. The rate of adsorption is increased at higher pressures and lower temperatures.

Desorption is the release of a substance from or through the surface of a material. In constant environmental conditions, an adsorbed substance will remain on a surface almost indefinitely. However, as the temperature rises, so does the likelihood of desorption occurring.

In practical terms, as the temperature of the environment fluctuates, water molecules are adsorbed and desorbed from the internal surfaces of the sample tubing, causing small fluctuations in the measured dew point.

Sample Tubing Length

The sample point should always be as close to the critical measurement point as possible, in order to obtain a truly representative measurement. The length of the sample line to the sensor or instrument should be as short as possible. Interconnection points and valves trap moisture, so using the simplest sampling arrangement possible will reduce the time it takes for the sample system to dry out when purged with dry gas.

Over a long tubing run, water will inevitably migrate into any line, and the effects of adsorption and desorption will become more apparent. It is clear from the graph shown above that the best materials to resist transpiration are stainless steel and PTFE.

Trapped Moisture

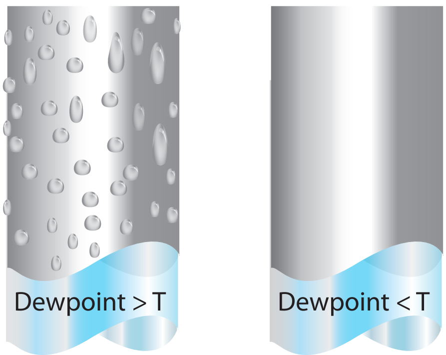
Dead volumes (areas which are not in a direct flow path) in sample lines, hold onto water molecules which are slowly released into the passing gas; this results in increased purge and response times, and wetter than expected readings. Hygroscopic materials in filters, valves (e.g. rubber from pressure regulators) or any other parts of the system can also trap moisture.

Sample Conditioning

Sample conditioning is often necessary to avoid exposure of sensitive measuring components to liquids and other contaminants which may cause damage or affect the accuracy over time, depending on the measurement technology.

Particulate filters are used for removing dirt, rust, scale and any other solids that may be in a sample stream. For protection against liquids, a coalescing filter should be used. The membrane filter is a more expensive but highly effective alternative to a coalescing filter. It provides protection from liquid droplets, and can even stop flow to the analyzer completely when a large slug of liquid is encountered.

Condensation and Leaks



Maintaining the temperature of the sample system tubing above the dew point of the sample is vital to prevent condensation. Any condensation invalidates the sampling process as it changes the water vapor content of the gas being measured. Condensed liquid can alter the humidity elsewhere by dripping or running to other locations where it may re-evaporate.

The integrity of all connections is also an important consideration, especially when sampling low dew points at an elevated pressure. If a small leak occurs in a high pressure line, gas will leak out but vortices at the leak point and a negative vapor pressure differential will also allow water vapor to contaminate the flow.

Flow Rates

Theoretically flow rate has no direct effect on the measured moisture content, but in practice it can have unanticipated effects on response speed and accuracy. The optimal flow rate varies depending on the measurement technology, and can always be found in the instrument or sensor manual.

An inadequate flow rate can:

- Accentuate adsorption and desorption effects on the gas passing through the sampling system.
- Allow pockets of wet gas to remain undisturbed in a complex sampling system, which will then gradually be released into the sample flow.
- Increase the chance of contamination from back diffusion: ambient air that is wetter than the sample can flow from the exhaust back into the system. A longer exhaust (sometimes called a pigtail) can also help alleviate this problem.
- Slow the response of the sensor to changes in moisture content.

An excessively high flow rate can:

- Introduce back pressure, causing slower response times and unpredictable effects on equipment such as humidity generators.
- Result in a reduction in depression capabilities in chilled mirror instruments by having a cooling effect on the mirror. This is most apparent with gases that have a high thermal conductivity such as hydrogen and helium.

POSSIBLE INJURY! The tubing, valves and other apparatus attached to this instrument must be adequate for the maximum pressure which will be applied, otherwise physical injury to the operator or bystander is possible.

Before disconnecting the Optisure from the gas line it is essential to vent the system to atmospheric pressure, otherwise severe injury could result.

7 CALIBRATION

7.1 Traceability

The calibration of this instrument is traceable to national standards. For this reason the instrument can only be calibrated in an accredited standards laboratory.

If these facilities do not exist, the instrument must be returned to the manufacturer, Kahn Instruments.

If required for the calibration process, the instrument's internal PRT can be made available for external connection as described in Section 3.10.

The **DCC** function can be disabled for calibration purposes (Refer to Section 3.6.1).

A calibration certificate bearing a three point calibration is issued with each instrument. If required, an option is available to add further specific calibration points. Contact Kahn Instruments for further information (for contact information go to www.kahn.com).

MICHELL Instruments

CERTIFICATE OF CALIBRATION

The under-mentioned item has been calibrated at the following points in the Michell Instruments' Humidity Calibration Laboratory against Test Equipment traceable to the NATIONAL PHYSICAL LABORATORY, Middlesex, United Kingdom and to the NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY, Gaithersburg, Maryland, USA.

Certificate Number	54321	*Ack Number*	A32123
Test Date	6 Nov 2012	*Test Equipment*	Q0238
Instrument Serial Number	123456		
Product Type	S8000		

Generated Dewpoint °C	*Instrument Display Dewpoint °C*	*Instrument Display Correction °C*
-59.4	-59.3	-0.10
-30.6	-30.6	0.00
10.1	10.0	+0.10

Comments:
Calibration PASS. The results are within specification at the measured points.

NOTE Traceability to National Physical Laboratory is over the range -90°C to +90°C.
Traceability to National Institute of Standards and Technology is over the range -75°C to +20°C
Uncertainty of measurement:
+/- 0.20 @ +20°C DP increasing linearly to +/- 0.40 @ -60°C DP then rising linearly to +/- 0.63 @ -75°C DP
+/- 0.31 between +20°C DP and +82°C DP
The uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95 %

Approved Signatory *22 Nov 2012*

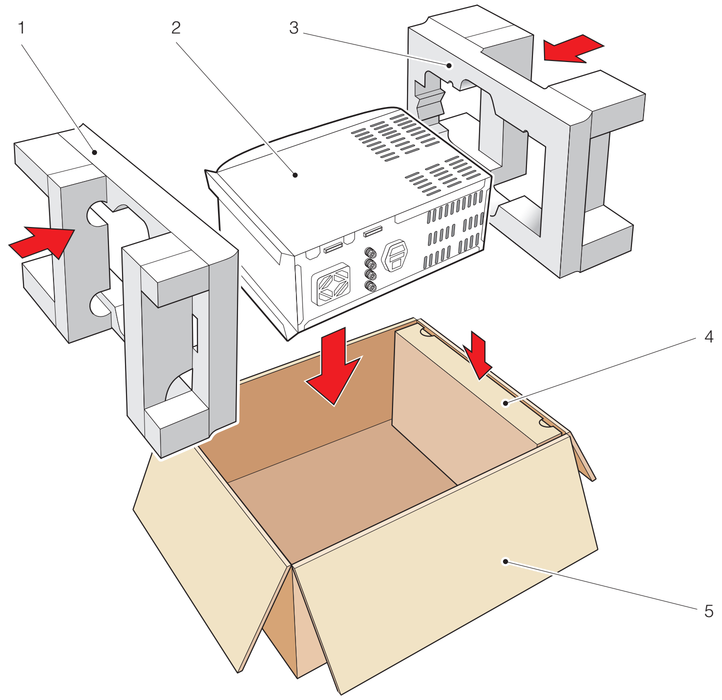
Michell Instruments Ltd.
www.michell.com

Figure 41 *Typical Calibration Certificate*

8 PREPARATION FOR SHIPPING

For shipping purposes, the instrument should be packed into its original carton, the latter providing the recommended degree of protection during transit. To prepare the instrument for shipping, proceed as follows.

1. Switch off the instrument and remove the power supply cable (see Section 2.5.1). If the instrument is rack mounted, first remove it from the rack, and remove the rack mount wings.
2. Remove the (optional) microscope and re-fit the blanking plug.
3. Remove the (optional) remote PRT (see Section 2.5.4).
4. If installed, remove the USB communications cable (see Section 2.5.6).
5. Remove the analog and alarm output connectors (see Section 2.5.2 and Section 2.5.3).
6. Remove any connections to the 4-wire PRT output binding posts (see Section 2.5.5).
7. Remove the connections to the **GAS IN** and **GAS OUT** ports (see Section 2.5.7).
8. Pack the instrument in its original case as shown in *Figure 42.* **NOTE: The accessories should be packed in the box (4). Unless returning for repair, it is not necessary to return either the microscope or the analog and alarm connectors. All cables and the remote PRT probe (if supplied) should be returned for checking.**
9. Enclose a packing list detailing all equipment contained in the box and seal the box. Ideally, for extra security, the box should be banded.



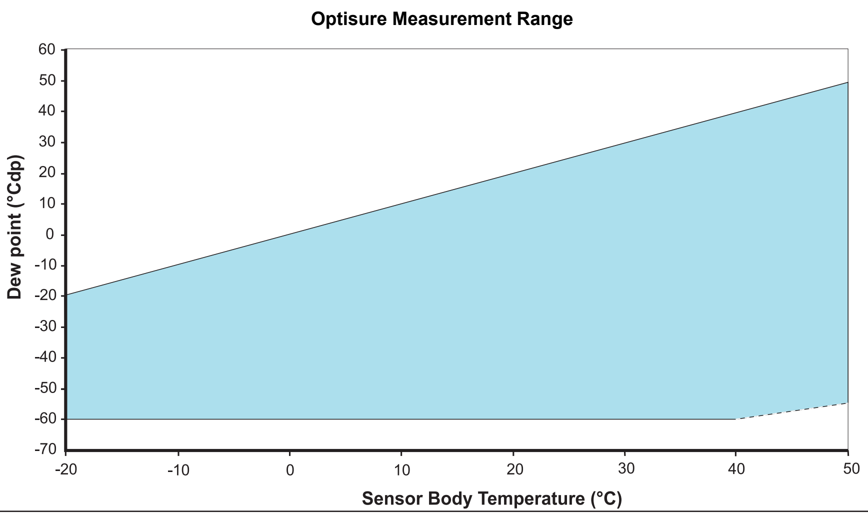
1 Side packing
2 Optisure Instrument
3 Side packing
4 Accessories box
5 Carton

Figure 42 *Instrument Packing Details*

Appendix A

Technical Specifications

Appendix A Technical Specifications

Dew-Point Sensor Performance	
Measurement Technology	Chilled Mirror
Operating Temperature Range	-4 to +122°F (-20 to +50°C)
Measurement Range	-76 to +104°Fdp (-60 to +40°Cdp) 
Accuracy	±0.1°C (±0.18°F)
Reproducibility	±0.09°F (±0.05°C)
Operating Pressure	Low Pressure Version: 0 to 14.5 psig (0 to 1 barg) High Pressure Version: 0 to 250 psig (0 to 17 barg)
Sample Flow Rate	0.2 to 2.1 scfh (0.1 to 1 Nl/min)
Detection System	Temperature regulated emitter with dual optic detection
Remote PRT Probe (Optional)	
Temperature Measurement	4 wire Pt100, 1/10 DIN class B
Measurement Accuracy	±0.1°C (±0.18°F)
Cable Length	6.6ft (2m) (820ft (250m) max)
Flow Sensor	
Measurement Accuracy	Typical ±5% uncalibrated
Measurement Range	0 to 1000ml/min
Integrated Pressure Sensor (Optional)	
Measurement Range	0 to 377 psia (0 to 25 bara)
Measurement Accuracy	0.25% Full Scale
Measurement Units	psia, bara, KPa or MPag

Monitor	
Resolution	User-selectable to 0.001 dependant on parameter
Measurement Units	°F and °C for dew point and temperature %RH, g/m^3, g/kg, ppm$_V$, ppm$_W$ (SF_6), for calculated humidities
Outputs	**Analog**: 3 channels, user selectable 4-20 mA, 0-20 mA or 0-1 V **Digital**: PC Communications using Modbus RTU over USB **Alarm**: Two volt free changeover contacts, one process alarm, one fault alarm; 1 A @ 30 V DC
HMI	High definition, blue LCD User-adjustable contrast Menu navigation via five button keypad
Data Logging	SD Card (512Mb supplied) and USB interface SD Card (FAT-16) - 2Gb max. that allows 24 million logs or 560 days, logging at 2 second intervals
Environmental Conditions	-4 to +122°F (-20 to +50°C)
Power Supply	85 to 264 V AC, 47/63 Hz
Power Consumption	100 VA
EMC - Class A Emissions Industrial Location Immunity	Complies with EN61236:1997 (+A1/A2/A3)
Mechanical Specifications	
Dimensions	Vertical: 17.5 x 7.9 x 13.8" (445 x 200 x 350mm) h x w x d 415mm (16.3") deep when microscope is mounted Horizontal: 7.3 x 17.3 x 18.8" (185 x 440 x 350mm) h x w x d 415mm (16.3") deep when microscope is mounted
Weight	Vertical: 23.7lb (10.75kg) Horizontal: 9.9kg (21.8lb)
General	
Storage Temperature	-40 to +140°F (-40 to +60°C)
Calibration	3-point traceable in-house calibration as standard

Appendix B

Formatting SD Cards

Appendix B Formatting SD cards

Before an SD card can be used for the storage of datalog results it must first be formatted. Initially the card must be connected to a card reader which must, in turn, be connected to the host computer. Most proprietary card readers connect to the host via a USB port. Almost all laptop/notebook PC's are equipped with an SD card reader slot.

The formatting procedure is as follows:

1. Insert the card into the card reader and open Windows Explorer. The card will be reported as Removable storage device.
2. Right click on the card icon and select **Format** from the pop-up menu (refer to *Figure 43)*.
3. The **Format** dialog box is now presented as shown in *Figure 44,* and the disk capacity is reported on the top line (1). This will depend upon the type of disk used (512 MB in this example).
4. In the **File system** box (2), *Figure 44,* select **FAT.**
5. In the **Allocation unit size** box (3), leave this set to Default allocation size.
6. If required, in the **Volume label** box (4), enter a volume label e.g. Optisure.
7. The SD card requires a full format so leave the **Quick format** box (5) unchecked.
8. Click the **Start** button (6). The message *(Figure 45)* will now appear. Click **OK** to proceed.

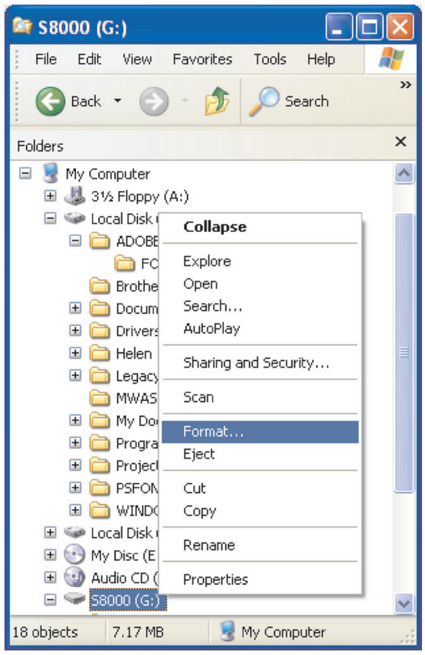


Figure 43 *Select Format*

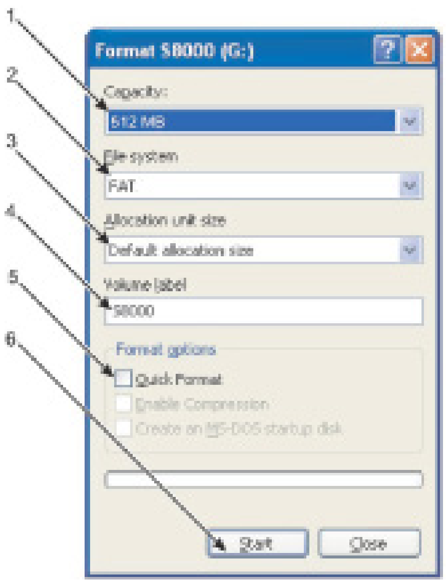


Figure 44 *Set Format Properties*

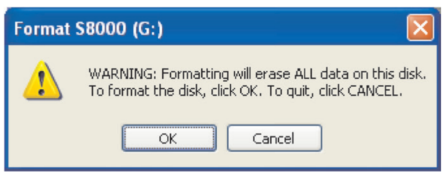


Figure 45 *Format Disc*

Appendix C

Calculations

Appendix C Calculations

C.1 Water Content

The accuracy of the humidity calculations was determined by comparing the displayed value to corresponding values calculated from the formulae below, using a PRT simulator to set a dew-point value and the Kahn Humidity Calculator to calculate the water vapor pressure (wvp).

ppm_V (dry) = (wvp/(101325-wvp) * 10^6
ppm_V (wet) = (wvp/101325) * 10^6
ppm_W SF^6 (wet & dry) = ppm_V * 0.12334954
g/kg = ppm_V * 0.0006212138
g/m^3 = (217/(273.15 + Dp)) * (wvp/100)

Note: ppm_V can be calculated on a dry or wet basis depending upon bit 10 in the units command register, which can be set via the Application software.

C.2 Temperature - Dew Point

PRT simulators are used to simulate the dew-point and ambient temperature sensors. For each pair of temperature readings the instrument display is read and the actual t-dp readings recorded. Each of these readings is then compared against calculated t-dp, readings using the same input parameters to the Kahn Humidity Calculator.

C.3 °C to °F Calculation

PRT simulators are used to input simulated temperatures, measured in °C, into both measurement channels.

For each measurement channel, the corresponding display is set to read the input temperature in °F. For each channel the temperature reading on the instrument display, corresponding to the series of simulated PRT inputs, is read and recorded. Each of these readings is then compared against a corresponding temperature calculated from the following formula.

Conversion formula. °F = ((°C*9)/5) +32

C.4 % RH Calculation

PRT simulators are used to input simulated dew-point and ambient temperatures, measured in °C, into both measurement channels.

For each pair of inputs, the reading on the instrument's % RH display is recorded. Each of these readings is then compared against a corresponding % RH value calculated by inputting the same parameters to the Kahn Humidity Calculator.

C.5 Conversion of bara to psia and kPa

Use a calibrated 4-20 mA source (Q0356) to simulate a range of applied pressures covering the instruments' full pressure measurement span of 0 to 377 psia (0 to 25 bara) (1.56 bar/mA).

For each input current, record the display reading for all three units.

For each display reading, calculate the corresponding pressure in the relevant units from the following formula.

Psia = ((bara-1)*14.5) + 14.7

Kpa = bara*100

Appendix D

Modbus

Appendix D Modbus RTU Communications

D.1 Introduction

Optisure Optical Hygrometer instruments have a Modbus communications interface via the USB port that enables remote access to the instrument's configuration and data logging facilities. This protocol offers two-way communication between a host (PC), (known as the master unit), and one or more instruments, (known as slave units).

Once communication is established by the master unit, reading or writing to holding registers within an addressed slave unit is possible. The master unit can obtain measured values and status information by reading registers and can respond to data contained within these registers by writing back.

The tables in this Appendix list these registers, as they apply to the Optisure instrument, and specify the number and data formats that apply to each register.

D.2 Basic Modbus Operation

There are two possible Modbus transmission modes - ASCII and RTU (Remote Terminal Unit). The Optisure instrument is classed as an RTU.

Communication between a host system (e.g. PC) operates on a Query-Response Cycle (see *Figure 46)*, where a specific Modbus function code, embedded in the query message, tells the addressed slave device what actions to perform using the information contained in the data bytes.

An error checkfield provides a method for the slave to validate the integrity of the message contents. If the slave makes a normal response, the function code in the response is an echo of the function code in the query and the data bytes will contain data collected by the slave e.g. holding register values or status information. If an error occurs, the function code is incremented by 80H (most significant bit set to 1) to indicate that the response is an error response, and the associated data bytes contain a code to define the error.

The error check field, CRC (Cyclic Redundancy Check), allows the master to confirm that the message contents are valid.

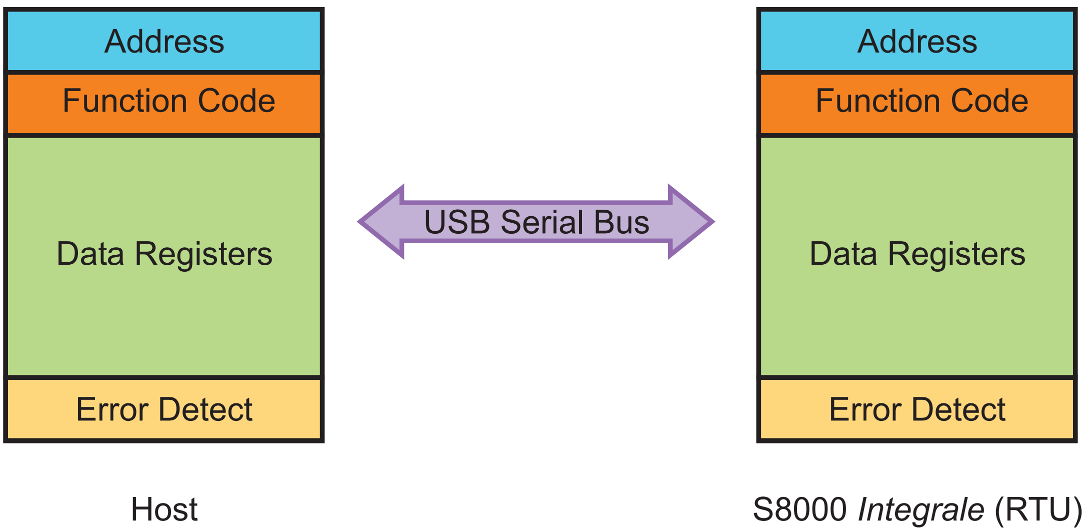


Figure 46 *Modbus Connection*

D.3 Modbus RTU Connections and Protocol

The physical connection from the master to the Optisure Optical Hygrometer uses a USB connection cable between the host and the instrument's communications connector. Refer to Section 2.5.6 for details of the connection of this cable.

The serial port protocol is as follows:

Baud Rate:	9600
Start Bits:	1
Data bits:	8
Parity:	None
Stop bits:	2

Typically, a Modbus RTU message is structured as follows:

Byte 1	Slave Address	Value 1-247
Byte 2	Modbus Function Code	Value 3 (e.g read register)
Byte 3	Start Address (Low byte)	Value 0 - 255
Byte 4	Start Address (High byte)	Value 0 - 255
Byte 5	No. Registers to read (Low byte)	Value 0 - 255
Byte 6	No. Registers to read (Low byte)	Value 0 - 255
Byte 7	Error Check Value	

D.4 Register Map

All the data values relating to the Optisure Optical Hygrometer are stored in holding registers. Each of these registers is two bytes (16-bits wide). Some of these registers contain instrument specific values e.g. its own unique system address, emitter drive values etc. and others are used to hold specific real time data e.g. measured dew-point temperature.

Each Modbus message has a two part address code, one for the low byte (bits 0 through 7) and one for the high byte (bits 8 through 15). The facility exists for multiple registers, specified by a high and low byte contained in the query message, to be addressed and read by the same message.

Table 7 describes the instruments' registers with their respective address locations, together with their relevant register configurations and register map definitions. **NOTE: Hexadecimal (Hex) addresses marked with an asterisk in Table 7 denote instrument specific parameters stored in the instrument's flash memory.**

The register maps, Tables 9 to 21, define the data allocated to each bit/byte of that specific register.

Address dec	Address hex	Function	Read/ Write	Default Value Hex	Register Config.	Register Map Definition
0	0000*	Instrument Address	R/W	0001H	H	INSTID
1	0001	Dew point Value – Hi Word	R		N	HUMIDITY_HI
2	0002	Dew point Value – Lo Word	R		N	HUMIDITY_LO
3	0003	Ambient Temperature – Hi Word	R		N	AMBTEMP_HI
4	0004	Ambient Temperature – Lo Word	R		N	AMBTEMP_LO
5	0005	RH	R		A	RH
6	0006	Pressure Value	R		J	PRESSURE
7	0007	PpmV – Hi Word	R		N	PPMV_HI
8	0008	PpmV – Lo Word	R		N	PPMV_LO
9	0009	PpmW(sf6) – Hi Word	R		N	PPMWSF_HI
10	000A	PpmW(sf6) – Lo Word	R		N	PPMWSF_LO
11	000B	g/m3 - Hi Word	R		N	GM3_HI
12	000C	g/m3 - Lo Word	R		N	GM3_LO
13	000D	g/kg – Hi Word	R		N	GKG_HI
14	000E	g/Kg – Lo Word	R		N	GKG_LO
15	000F	Flow Value	R		H	FLOW_RATE
16	0010	Mirror Condition	R		J	MIRROR_COND
17	0011	Heat Pump Drive	R		H	HP_DRIVE
18	0012	Status	R		D	STATUS
19	0013*	DCC duration + Hold Time Duration minutes	R/W		K	DCC_HOLD_TIME
20	0014*	Measurement Time Hours + Minutes	R/W		K	MEASURE_TIME
21	0015*	Phase Time Hours	R		H	PHASE_TIME_HRS
22	0016	Phase Time Minutes + Phase Time Seconds	R		K	PHASE_TIME_MIN_SEC
23	0017*	Film thickness setting	R/W		A	FILM_THICKNESS
24	0018	Live film thickness value	R		A	LIVE_FILM_THICKNESS
25	0019*	Analog 1 output maximum value	R/W		M	MAX_MA1
26	001A*	Analog 1 output minimum value	R/W		M	MIN_MA1
27	001B*	Analog 2 output maximum value	R/W		M	MAX_MA2
28	001C*	Analog 2 output minimum value	R/W		M	MIN_MA2
29	001D*	Analog 3 output maximum value	R/W		M	MAX_MA3
30	001E*	Analog 3 output minimum	R/W		M	MIN_MA3
31	001F*	Analog output configuration 1	R/W		B1	OP_SELECTION1
32	0020*	Analog output configuration 2	R/W		B2	OP_SELECTION2
33	0021*	Logging Interval	R/W		H	LOG_INTERVAL
34	0022*	Units/ Command	R/W		E	UNITSCOMMAND
35	0023*	Mirror Temp Set-Point during DCC	R/W		M	MIRROR_TEMP_SETP
36	0024*	Emitter Drive	R/W		H	EMITTERDRIVE
37	0025	Stability Time	R/W		H	STABILITY_TIME
38	0026	RTC Year(val1) + Month (val2)	R/W		K	YEARMONTH
39	0027	RTC Date (val1) + Hours(val2)	R/W		K	DATEHRS
40	0028	RTC Mins(val1) + Secs (val2)	R/W		K	MINSSECS
41	0029*	Display Setting 1	R/W		F	DISPLAY_SETTING1
42	002A*	Display Setting 2	R/W		F	DISPLAY_SETTING2
43	002B	N/A				
44	002C	N/A				
45	002D	N/A				
46	002E	Filename DDMM or MMDD	R		L	FILENAME_DDMM
47	002F	Filename HHMM	R		L	FILENAME_HHMM
48	0030*	Firmware Version Number	R		A	FIRM_VER
49	0031*	N/A				
50	0032*	N/A				
51	0033*	N/A				
52	0034*	Process Alarm Configuration / Display Contrast	R/W		P	ALARMCONFIG_DISPCONT
53	0035*	Process Alarm Set Point	R/W		M	PROCESSALARM_SP_HI

Table 7 Modbus Holding Register Map

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r

Value

Sign bit = 1 for -ve values (signed int)
7FFF = 327.67
8FFF = -327.68
The value in bits (15 to 0) + 1 is divided by 100 to give 0.01 resolution for dewpoint and temperature values

Table 8 Register Configuration A

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Analogue O/P 2								**Analogue O/P 1**							
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
DP = 00000000 Temp = 00000001 ppm(v) = 00000010 ppm(w) sf6 =00000011 g/kg = 00000100 g/m^3 = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001								DP = 00000000 Temp = 00000001 ppm(v) = 00000010 ppm(w) sf6 =00000011 g/kg = 00000100 g/m^3 = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001							

Table 9 Register Configuration B1

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
								Analogue O/P 3							
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
		Analogue O/P 3 00 = 0 - 20mA 01 = 4 - 20mA 10 = 0 - 1V		**Analogue O/P 2** 00 = 0 - 20mA 01 = 4 - 20mA 10 = 0 - 1V		**Analogue O/P 1** 00 = 0 - 20mA 01 = 4 - 20mA 10 = 0 - 1V		DP = 00000000 Temp = 00000001 ppm(v) = 00000010 ppm(w) sf6 =00000011 g/kg = 00000100 g/m^3 = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001							

Table 10 Register Configuration B2

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	r	r	r	r	r/w	r/w	r	r	r	r	r	r
1 = Optics Reset	1 = Display Hold	1 = Max Cool Initiate	1 = DCC Initiate	1 = Start Logging 0 = Stop Logging	1 = FAST (Frost Assurance)	1= Fault Alarm	1 = Humidity Alarm	1 = External PRT	1 = Initiate Standby	In Control = 00H Heating = 01H Cooling = 10H		Measurement = 0000H DCC = 0001H Data Hold = 0010H Max Cool = 0100H Standby = 1000H			

Table 11 Register Configuration D Status Word

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
Language English = 0000 Chinese = 1111				Reset Defaults	1 = FAST Enable	1 DP = 00H 2 DP = 01H 3 DP = 10H		N/A	N/A	Psig = 00H Barg = 01H kPa = 10H		Measurement = 0000H DCC = 0001H Data Hold = 0010H Max Cool = 0100H Standby = 1000H			

Table 12 Register Configuration E Units

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Display 2								**Display 1**							
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
DP = 00000000 Temp = 00000001 ppm(v) = 00000010 ppm(w) sf6 =00000011 g/kg = 00000100 g/m³ = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001								DP = 00000000 Temp = 00000001 ppm(v) = 00000010 ppm(w) sf6 =00000011 g/kg = 00000100 g/m³ = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001							

Table 13 Register Configuration F Display Setting A

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Main Value to Log								**Display 3**							
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w

Main Value to Log	Display 3
DP, Temp, Press and Flow are logged by default ppm(v) = 00000010 ppm(w) sf6 =00000011 g/kg = 00000100 g/m^3 = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001	DP = 00000000 Temp = 00000001 ppm(v) = 00000010 ppm(w) sf6 =00000011 g/kg = 00000100 g/m^3 = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001

Table 14 Register Configuration F Display Setting B

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w

Unsigned Integer range 65535

Table 15 Register Configuration H

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r

← *Value* →

Sign bit = 1 for -ve values (signed int)
7FFF = 3276.7
8FFF = -3276.8
The value in bits (15 to 0) + 1 is divided by 10 to give 0.1 resolution for dewpoint and temperature values

Table 16 Register Configuration J

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w

← Val1 → ← Val2 →

Val1 & 2 are in BCD, therefore 10H = 10, 58H = 58 and 09H = 9, so as a result, A to F are not valid values

Table 17 Register Configuration K

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w

← Val1 → ← Val2 →

Values in HEX i.e. 17th March = 11H for Val1 and 03H for Val 2.

Table 18 Register Configuration L

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r

← *Value* →

Sign bit = 1 for -ve values (signed int)
7FFF = 32767
8FFF = -32768

Table 19 Register Configuration M

The humidity values for sensors 1 & 2 are represented in IEEE-754 single precision floating point format, in order to cater for the wide range in the value of ppm_V. This format is 'Big Ended' which means that the high byte is at a lower address in memory than the Lo byte, and is represented as such in the register memory map. The IEEE-754 format is shown below.

Bit 31 Sign bit 0 = + 1 = -	**Bits 30 to 23** Exponent Field Has +127 bias value	**Bits 22 to 0** Mantissa Decimal representation of binary, where 1.0 ≤ value < 2.0

Table 20 Register Configuration N

Register Configuration N - Floating Point Representation

Examples of floating point to HEX are shown below:

Example 1 +10.3

Sign bit = 0

Exponent = 3, therefore exponent field = 127 + 3 = 130, & bits 30 to 23 =10000010

The mantissa = 1.2875 which in binary representation = 1.01001001 1001 1001 1001 101

Adjusting the mantissa for the exponent moves the decimal point to the right if positive and to the left if negative

As the exponent is = 3 then the mantissa becomes = 1010.0100 1100 1100 1100 1101, therefore:-

1010 = (1x23 + (0x22) + (1x21) + (0x20) = 10 and

0100 1100 1100 1100 1101 = $(0x2^{-1})$ +$(1x2^{-2})$ +....+ $(1x2^{-20})$ = 0.3

Therefore the word value = 0100 0001 0010 0100 1100 1100 1100 1101 = 4124CCCD

Consequently for sensor 1, register 0001 = 4124 and register 0002 = CCCD

Example 2 0.0000045

Sign bit = 1

Exponent = -18, therefore exponent field = 127 + (-18) = 109, and bits 30 to 23 = 01101101

The mantissa = 1.179648 which in binary representation = 1.00101101111111010110101

i.e. $(1x2^{-18})$ +$(1x2^{-21})$ + $(1x2^{-23})$ etc = 0.0000045

Therefore the word value = 1011 0110 1001 0110 1111 1110 1011 0101 = B696FEB5

Consequently for sensor 1 register 0001 = B696 and register 0002 = FEB5

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Process Alarm Configuration								**Display Contrast**							
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
DP = 00000000 Temp = 00000001 ppm(v) = 00000010 ppm(w) sf6 =00000011 g/kg = 00000100 g/m^3 = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001								0 - 255							

Table 21 Register Configuration P

Appendix E

Application Software Installation

Appendix E Installation of the Application Software

Optisure Optical Hygrometer instruments have a Modbus communications interface via the USB port that enables remote access to the instrument's configuration and data logging facilities. This protocol offers two-way communication between a host (PC) (known as the master unit), to one or more instruments (termed slave units).

Once communication is established by the master unit, reading or writing to holding registers within an addressed slave unit is possible. The master unit can obtain measured values and status information by reading registers and can respond to data contained within these registers by writing back.

The following tables list these registers, as they apply to the Optisure instrument and specify the number and data formats that apply to each register.

A copy of the application software can be found on the CD delivered with the instrument or downloaded from http://www.kahn.com/uk/support/sware-downloads.htm

1. Double click the zip file to open the Optisure application software and launch the Optisure.exe file. Follow the set-up procedure.
2. Select the language to be used during the installation.
3. Exit all other Windows programs before running the Setup program.
4. Accept the licensing agreement.
5. The System information window will specify whether or not the PC meets or exceeds the minimum requirement for Optisure application software.
6. Enter the following authorization code: **7316-MIL1-8000**.
7. Amend the destination directory if desired. The default directory is C:\Program Files\Optisure Application Software.
8. Select the program folder. The default program folder is Kahn Instruments\Optisure Application Software.
9. Launch the installation from the installation summary window.
10. Restart the computer to finalize the installation.

If the software installation has been successful, Windows should recognize the Optisure USB connection and automatically load the relevant drivers. This can be checked in Windows Device Manager, and if successful, is listed under the Ports (COM & LPT) category and should look similar to that illustrated in *Figure 47*.

To select the Device Manager, click Start and select Control Panel. Double click on the System icon and select the Hardware tab. Select Device Manager. Failing this a prompt will show to load these drivers which can be installed from the CD supplied.

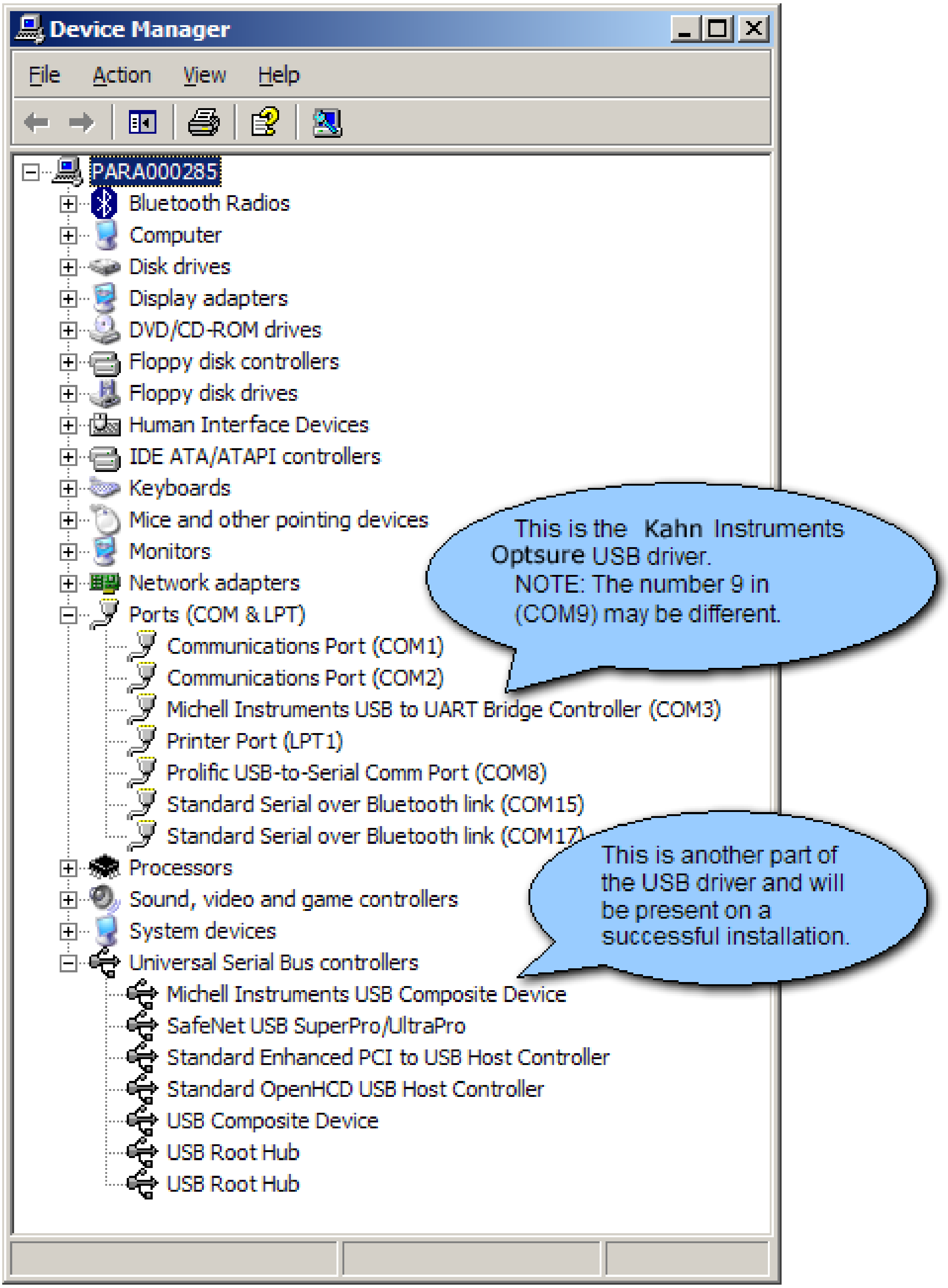


Figure 47 *Device Manager Screen*

To communicate with the Optisure, the software needs to know which communications (USB) port the Optisure is connected to. On first launch, the software will ask for the communications port number, which can be either automatically detected or manually selected. A screen shot of the communications window is shown below:

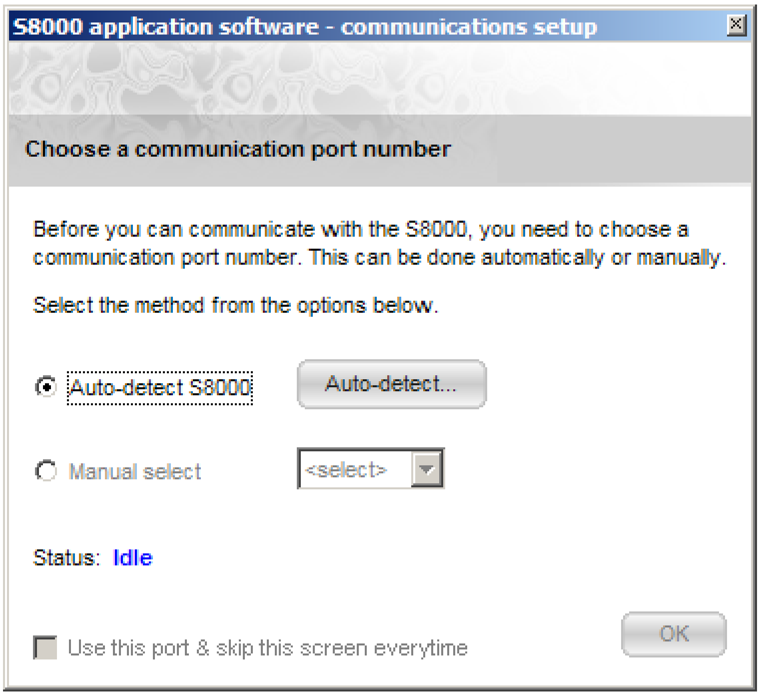


Figure 48 *Communications Window*

Clicking Auto-detect will prompt the software to search for the USB driver in Windows Device Manager. From that, it will determine which USB port the Optisure is connected to and establish a connection automatically.

Manual selection of a communications port is provided in the unlikely event that the software cannot auto-detect it.

NOTE: Upon successfully establishing communication, record the port number and, in future, skip this window by ticking the 'Use this port & Skip this screen every time' option.

Once communications have been established, click the **OK** button to go to the Options window. The latter provides two choices; Data acquisition and Edit variables. Choose either Data acquisition if continuous charting, display and logging of instrument readings is required or Edit variables if only the editing of instrument variables (configuration) is required.

Appendix F

EC Declaration of Conformity

Appendix F EC Declaration of Conformity

EC Declaration of Conformity

MICHELL Instruments

Manufacturer: **Michell Instruments Limited**
48 Lancaster Way Business Park
Ely, Cambridgeshire
CB6 3NW. UK.

CE

declare under our sole responsibility that the product

S8000 Integrale

complies with all the essential requirements of the EC directives listed below.

2004/108/EC	**EMC Directive**
2006/95/EC	**Low Voltage Directive (LVD)**

..and has been designed to be in conformance with the relevant sections of the following standards or other normative documents.

EN61326-1: 2006	Electrical equipment for measurement, control and laboratory use – EMC requirements – Group 1, Class A equipment. Emissions and Basic Immunity. IEC61000-3 & IEC61000-4
EN61010-1:2001	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements

Andrew M.V. Stokes, Technical Director

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